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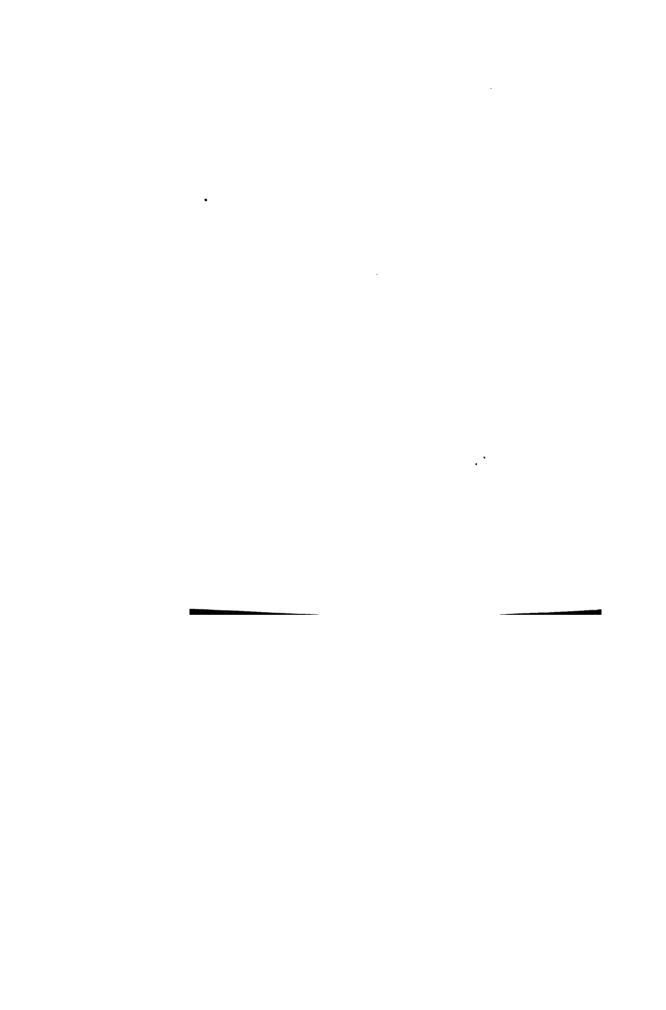
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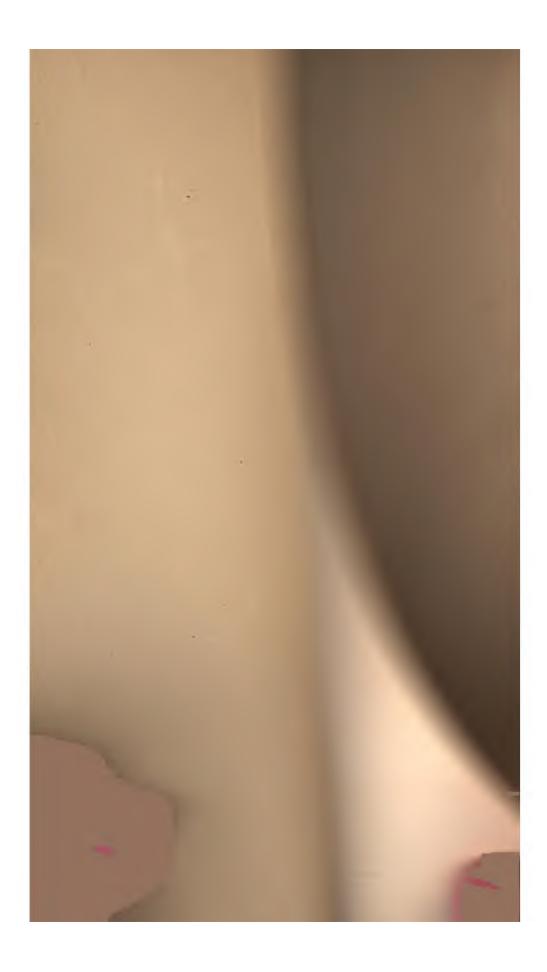
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# ODERN SURGERY

GENERAL AND OPERATIVE

BY

#### JOHN CHALMERS DA COSTA, M.D.

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OF THE MEDICAL RESERVE CORPS, U. S. A.

Edition, Thoroughly Revised and Enlarged with

Illustrations, some of them in Colors

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"Yet each man, following his sympathies,
Unto himself assimilating all,
Using men's thoughts and forms as steps to rise,
Who speaks at last his individual word,
The free result of all things seen and heard,
Is in the noblest sense original.
Each to himself must be his final rule,
Supreme dictator, to reject or use,
Employing what he takes but as his tool.
But he who, self-sufficient, dares refuse
All aid of men, must be a god or fool."

W. W. Story ("A Contemporary Criticism").

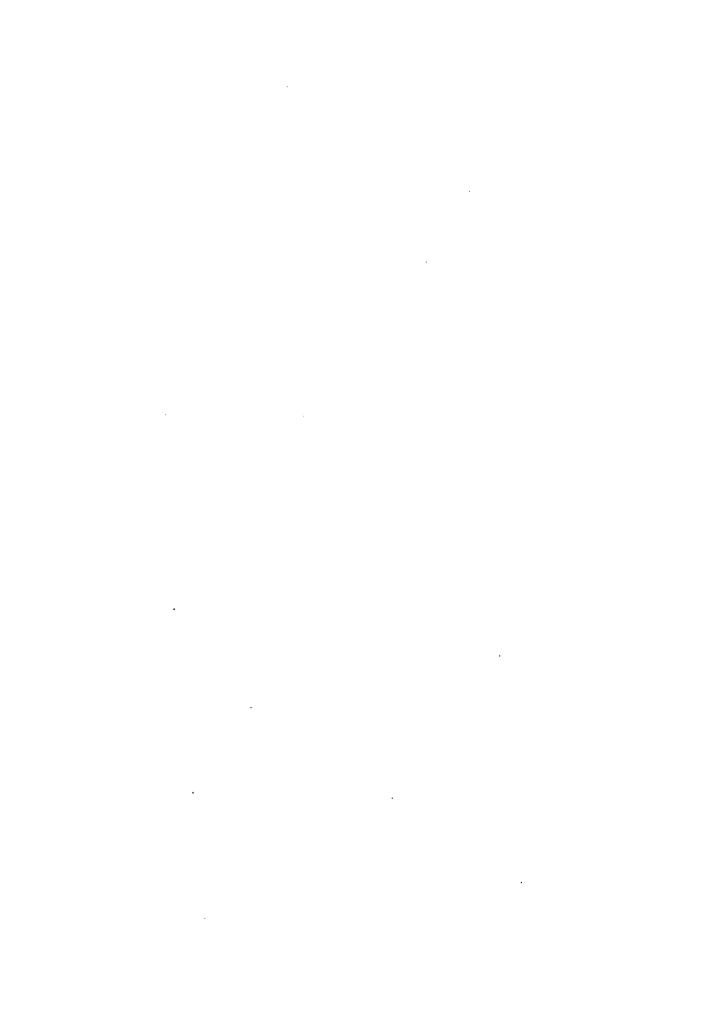
THIS BOOK IS DEDICATED TO THE CHIEF SURGEON AND INSPIRATION OF ONE OF THE GREATEST, MOST PROGRESSIVE, AND
MOST INFLUENTIAL SURGICAL CLINICS IN THE WORLD.
A CLINIC FROM WHICH COME IMPORTANT FACTS,
REAL IDEAS, AND BRILLIANT MEN.
TO THE OPERATOR, THE TEACHER, THE INVESTIGATOR, AND THE

SURGICAL PHILOSOPHER. TO

DR. WILLIAM STEWART HALSTED,

THE DISTINGUISHED PROFESSOR OF SURGERY IN

JOHNS HOPKINS UNIVERSITY.



### PREFACE TO THE SIXTH EDITION

LESS than three years ago the fifth edition of this book was published, yet a revised edition is now necessary. The work of revision has proved an arduous task. It has been found most difficult to select from the large number of books and reports and the great mass of periodic literature those matters which appear to be genuine advances. It has often been a matter of embarrassing uncertainty to choose what should go in the new edition and what should be removed from the text of the former edition. New things are not always true things, and even long accepted views may happen to be wrong. In investigating alleged discoveries and advances, I have endeavored to bear in mind the thought of Victor Hugo that new things may be either constellations of profundity or stars made by duck's feet in the soft mud of the pond. Further, in trying to estimate the worth of recent views, one must always be on the lookout for what Junius calls false facts. Many procedures are still on trial and their real value has not as yet been determined. The real test of all views is experience, and ample experience can come only after considerable time.

In spite of these critical deductions, a reading of the literature of the last three years impresses one with the reality and magnificence of the progress that is being made in Surgery. Almost every section of this book has been altered or added to for the sixth edition. Particular mention has been made of arteriorrhaphy, a procedure which is founded on the investigations of Murphy, Carrel, and Matas; Crile's arteriovenous anastomosis for affecting transfusion of blood; Brewer's tubes for transfusion; the use of Halsted's aluminium bands in the treatment of aneurism; the operative treatment of recent fractures; Horsley's operation for chronic spinal meningitis; the use of positive and negative air pressure in intrathoracic surgery; Murphy's method of treating acute peritonitis; Cushing's operation of decompression for brain tumors; Bier's intravenous local anesthesia; the parathyroid glandules; the intraglandular extirpation of goiter, which is favored by Halsted and the Mayos; the Lorenz treatment of hip disease by weight bearing and fixation; cystoscopy and catheterization of the ureters; gunshot-wounds in war; Bier's treatment of inflammation; Wright's views on inflammation; Rosenberger's method of diagnosticating tuberculosis by finding the bacilli in the blood; immunity with a sketch of antibodies, of opsonins, and of phagocytosis;

bacterial vaccines; untoward effects of sera; tuberculin in diagnosis; fat embolism; erysipeloid; human glanders; Wassermann's reaction for syphilis; the serum diagnosis of cancer; tumors in general; syphilis; acute dilatation of the stomach, mesenteric cysts, congenital idiopathic dilation of the colon, teratoids and dermoids of the sacrococcygeal region; gonorrhea; ankylosis; radium, electrical injuries, and the x-rays.

Unfortunately, the book grows larger with each edition, and I view this growth with regret and apprehension, feeling somewhat like the elder Weller when he saw the woman drink nine and a half breakfast-cups of tea and noticed her "swellin' wisibly" before his "wery eyes."

In the preparation of this edition I received valuable help in the chapters on Fractures and Dislocations, from Dr. T. Turner Thomas, of the University of Pennsylvania; in the chapter on Orthopedic Surgery, from my colleague, Dr. H. Augustus Wilson, Professor of Orthopedic Surgery in the Jefferson Medical College; in the chapter on the x-rays, from Dr. W. F. Manges, Chief of the x-ray Department of the Jefferson Hospital; in the sections on Cystoscopy and Catheterization of the Ureters and Gonorrhea, from Dr. Thomas C. Stellwagen, Chief of the Genito-urinary Out-patient Department of the Jefferson Hospital, in the section on Cleft Palate, from Dr. Wm. J. Roe, Chief Assistant in the Department of Oral Surgery; and from my Assistant, Dr. George J. Schwartz, in a number of important things. I return my cordial thanks to Dr. Corben J. Decker, U. S. Navy (retired), for the multitude of efficient services he has rendered so constantly and with such unfailing cheerfulness.

JOHN CHALMERS DA COSTA.

2045 WALNUT STREET, PHILADELPHIA.

January, 1910.

#### PREFACE TO THE FIRST EDITION

THE aim of this Manual is to present in clear terms and in concise form the fundamental principles, the chief operations, and the accepted methods of modern surgery. The work seeks to stand between the complete but cumbrous text-book and the incomplete but concentrated compend.

Obsolete and unessential methods have been excluded in favor of the living and the essential. There has been no attempt to exploit fanciful theories nor to defend unprovable hypotheses, but rather the effort has been to present the subject in a form useful alike to the student and to the busy practitioner.

The opening chapter is devoted to Bacteriology because the author profoundly believes that without some knowledge of the vital principles of this branch of science the vast importance of its truths will be ill-appreciated, and there will be inevitable failure in the application of aseptic and antiseptic methods.

Ophthalmology, gynecology, rhinology, otology, and laryngology have not been considered, because of the obvious fact that in the advanced state of specialized science only the *specialist* is competent to write upon each of these branches.

In Orthopedic Surgery are discussed those conditions which must in the very nature of things often be cared for by the surgeon or the general practitioner (such as hip-joint disease, club-foot, Pott's disease of the spine, flat-foot, etc.). The limited space at command precluded the introduction of a special division on diseases of the female breast. A large amount of space has been devoted to Fractures and Dislocations, the enormous practical importance of these subjects calling for their full discussion. Operative Surgery is considered in separate sections, the most important procedures being fully described, giving also the instruments necessary, and the positions assumed by patient and operator. This method has been adopted to fit the work for use in surgical laboratories.

Many systems, manuals, monographs, lectures, and journal articles have been consulted, and credit has been given in the text for statements and quotations. Special acknowledgment is due to the American Text-Book of Surgery, edited by Keen and White; to the surgical works of Ashhurst, Agnew, the elder Gross, Duplay and Reclus, Esmarch, Albert, Koenig, Wyeth, and Bryant; to the Manual of Surgery, edited by Treves; to the International Encyclopædia of Surgery, edited by Ashhurst; to the Surgical Pathology of Billroth and of Bowlby; to the Diagnosis of A. Pearce Gould; to the Surgical Dictionary of Heath; to the Rest and Pain of Hilton; to the works on operative surgery of Barker, Jacobson, Treves, Stephen Smith, and Joseph Bell; to the Minor Surgery of Wharton; to the dictionary of Foster and of Gould; to the Principles of Surgery of Senn; to the orthopedic writings of Sayre;

to the work on Diseases of the Male Generative Organs of Jacobson; to the System of Genito-urinary Diseases, edited by Morrow; and to the treatises on Fractures and Dislocations of Sir Astley Cooper, Malgaigne, Hamilton, Stimson, and T. Pickering Pick.

The Author returns his thanks to the numerous writers who courteously authorized the reproduction of special illustrations, and particularly to Professors Keen and White for their free permission to draw upon the American Text-Book of Surgery, from which a number of pictures have been taken, distinctively those referring to Bandaging; to Mr. John Vansant for the great amount of labor so ably and cheerfully performed; and to Dr. Howard Dehoney for the preparation of the Index.

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# MODERN SURGERY.

#### I. BACTERIOLOGY.

BACTERIOLOGY is the science of micro-organisms. Though a science in the youth of its years, bacteriology has not only profoundly altered, but it has also revolutionized, pathology, and our views of surgery would be in-

complete, misleading, and erroneous without its aid.

Micro-organisms, or microbes, are minute non-nucleated vegetable cells closely connected with fungi and algae, many of them being visible only by means of a highly powerful microscope and after they have been brightly stained. The contents of these cells are protoplasm and nuclear chromatin enclosed by a structure containing cellulose. There is considerable evidence that some diseases are caused by bacteria so minute as to escape detection even by the most powerful microscope. The French Yellow Fever Commission asserted that the yellow fever micro-organism passes through a porcelain filter ("Annals of the Pasteur Institute," Nov., 1903). The micro-organism of rabies probably does the same thing.

Even in the most remote times some have believed that "the mysterious cause of contagious and epidemic diseases must be sought in living entities" (Monti on "Modern Pathology"). Bacteria were discovered by Leeuwenhoek in 1675, but definite knowledge of these minute bodies and of their actions dates from the study of fermentation by the celebrated Frenchman Pasteur, who in 1858 asserted that every fermentation has invariably its specific ferment; that this ferment consists of living cells; that these cells produce fermentation by absorbing the oxygen of the substance acted upon; that putrefaction is caused by an organized ferment; that all organized ferments are carried about in the air; and that entirely to exclude air prevents putrefaction or fermentation.

In 1860 Pasteur published the observation that sterile liquids will not be contaminated by air if the air gains entry only through a long curved tube, the reason being that dust and growths fall from the entering air by gravity ("Comptes rendus," 1860).

In 1863 Pasteur published his experiments which proved that beer cannot ferment without yeast and that wine received in sterile vessels and kept from external contamination will not undergo ammoniacal change.

The views of Pasteur, which were radical departures from accepted belief, inaugurated a bitter controversy, and in that controversy were born the microbic theory of disease, the doctrine of preventive inoculation, antiseptic surgery, and serum-therapy.

The word microbe, which signifies a small living being, was introduced in 1878 by the late Professor Sédillot, of Paris. At that time the nature of these bodies was in doubt; some thought them animal, and called them microzoaria; others thought them vegetable, and called them microphyta; the

designation "microbe" does not commit us to either view. We now know them to be vegetable, but the term "microbe" has remained in use,

The micro-organisms connected with disease in man are divided into:

- 1. Yeasts, Saccharomyces, or Blastomycetes;
- 2. Moulds, or Hyphomycetes;
- 3. Bacteria, or Schizomycetes.

Yeasts or budding fungi include most of those fungi which can cause alcoholic fermentation in saccharine matter. They consist of small cells which can live without free oxygen, and which multiply by gemmation or budding. Definite nuclei are not demonstrable in the cells. When a cell multiplies a small bud of protoplasm projects from or near the end or buds project from or near both ends of the cell. Buds increase progressively in size and a constriction appears between each bud and the parent-cell. Each constriction deepens as the corresponding projection enlarges, until the bud attains a considerable size and is cast off as a daughter-cell. In some cases buds are not cast off, but remain attached, a chain or series of rounded yeast-cells being formed. These cells contain spores when nourishment is insufficient. Under certain conditions yeast fungi can form interwoven threads called mycelial threads.

Moulds or filamentous fungi consist of filaments, each filament being composed of a single row of cells arranged end to end, and all filaments springing from a germinal tube which grows from a germinating spore. The yeast fungi are the common, but not the only cause of fermentation. Mould fungi are connected with processes of decomposition. Putrefaction is due to bacteria and retards the growth of yeasts and moulds.

Most yeasts and moulds grow best upon dead organic matter, some attack plants, a few the lower animals, and a very few grow upon or in the tissues of the human body.

The oidium albicans is a mould fungus which by growing in the mucous membrane produces the disease known as thrush. This disease attacks especially the mucous membrane of the mouth and pharynx, but occasionally the growth takes place upon the esophagus, the vocal cords, the stomach, the vagina, the respiratory tract, and the areola of the breast of a nursing woman. The proliferating fungus presents the appearance of milky white spots which by thickening and coalescence form curd-like masses, the superficial layer of epithelium being raised and cast off. Thrush is particularly common in infants suffering from marasmus, but it may occur in adults.

Blastomycetes dermatitis is an inflammation of the skin due to yeast fungi and bearing a resemblance to tuberculosis or syphilis. Sanfelice and



Fig. 1.-Actinomyces (Ziegler).

others maintain that yeasts are responsible for the growth of malignant tumors. It is certain that yeasts may exist in a carcinoma and can be cultivated, but proof is entirely lacking that they are anything but a contamination. Many skin diseases are due to fungi; among them should be mentioned: Favus, pityriasis versicolor, herpes tonsurans, parasitic sycosis, and eczema marginatum.

Actinomycosis is due to the ray-fungus (Fig. 1; see page 310). It is uncertain in which group the ray-fungi should be placed; it is quite certain that

more than one variety exists, and they seem to occupy a place between moulds and bacteria. Madura-foot, or mycetoma, is due to the streptothrix Madura.

Schizomycetes or bacteria chiefly claim our attention. It is important to remember that the term "bacteria," though applied to the class schizomycetes, has also a more restricted application—that is, to a division of the class; it may mean either schizomycetes in general, or rod-shaped schizomycetes, whose length is not more than twice their breadth. In this work it is employed to designate schizomycetes as a class.

Bacteria are minute, unbranched, non-nucleated, vegetable cells, free from chlorophyl, varying in shape and occasionally presenting locomotive flagella. The cell consists of a cell membrane, a layer of protoplasm, and some central fluid. No true nucleus has yet been demonstrated, but granules are found within the cells which some call metachromatic bodies (Babés) and others nuclei (Ernst). The cell membrane varies greatly in thickness, and when it is very thick the cell is said to have a capsule. The round cells have a smooth outer surface, but some of the rod-shaped cells show many flagella or at the end a single flagellum (Fig. 2). Flagella enable some bacteria to move (motile bacteria), but all organisms which possess them are not motile, and under certain conditions bacteria without flagella may develop them, or organisms which possess flagella may lose the power to develop them.

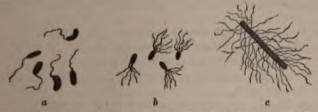


Fig. 2.—Types of flagella. a, Vibrio choleræ, one flagellum at the end-monotrichia type; b, Bact, syncyaneum tuft of flagella at the end, rarely at the side—Lophotrichia type; c, Bact, vulgare, flagella arranged all about—Peritrichia type (Lehmann and Neumann).

Some bacteria, known as non-pathogenic, cannot grow and produce poison either in the tissues, in wound-fluid, or in the fluid moistening a mucous surface. Others grow upon dead organic matter, but are not able to invade living tissues. They can live and multiply in the discharge from a wound or in the fluid covering a mucous surface and are called saprophytes, saprophytic microbes, or putrefactive bacteria. Obligate saprophytes only live in dead matter and never become parasites. Facultative saprophytes can be parasites and can also grow in dead organic matter. Bacteria, known as the pathogenic, under certain conditions invade living tissue and cause various diseases. Parasitic bacteria can grow on or in the tissues of the body. Obligate parasites are those which have not been cultivated outside of the body (as the bacilli of leprosy). Facultative parasites usually live outside the body, but may enter into the body and produce disease. The schizomycetes vary much in shape, size, color, arrangement, mode of growth, and action upon the body. One form cannot be transformed into another, but each maintains its specific identity. Every organism comes from a pre-existing organism, this being true of all forms. Pasteur proved that spontaneous generation is impossible. The protoplasm

of these cells can be stained with anilin colors, and the cell-wall is more readily detected after treating it with water, which causes it to swell.

Many bacteria are colored; others are colorless. Some move (motile bacteria); others do not move (amotile bacteria). The bacilli of anthrax and tuberculosis and all cocci are amotile. Most bacteria can change from motile to amotile, or from amotile to motile, when subjected to certain changes of soil and environment. The oscillations of cocci are physical in nature, not vital; they are Brunonian or Brownian movements, movements due to alterations in equilibrium because of currents or changes of level in the fluid in which the micro-organisms are contained. Bacteria seem to possess the power of attracting elements necessary for their nutrition (positive chemiotaxis or chemotaxis) and of repelling harmful elements (negative chemiotaxis or chemotaxis).







Fig. 3.-Micrococci.

Fig. 4.-Bacilli.

Fig. 5.-Spirilla

Forms of Bacteria. The three chief forms of bacteria are-

 The Coccus or Micrococcus—the berry-shaped, oval, or round bacterium (Fig. 3);

2. The Bacillus-the rod-shaped bacterium (Fig. 4);

3. The Spirillum or Vibrio—the corkscrew-shaped or spiral bacterium (Fig. 5). A short spiral organism is called a comma bacillus.

De Bary compares these forms, respectively, to the billiard-ball, the lead-

pencil, and the corkscrew.

Cocci and Bacilli.—As surgeons we have to do only with cocci and bacilli.

Cocci may be designated according to their arrangement with one another;



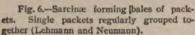




Fig. 7.—Ascococcus Billrothii Cohn (after F.

namely, when existing singly they are called *monococci* (Fig. 3); in pairs they are called *diplococci* (Fig. 8, A); arranged end to end in a chain they are called *streptococci* (Fig. 8, C); in group side by side clustered like a bunch of grapes they are called *staphylococci* (Fig. 8, B); in groups of four they are called plate *cocci*, or *tetracocci*; in cubical groups they are called *sarcinæ* or *wool-sack* cocci (Fig. 6). Irregular masses, resembling frog-spawn, constitute *zoöglea masses* (Fig. 9). The gelatinous matter in such a mass is formed by a transformation in the walls of the bacteria. The term *ascococci* is applied to a group of cocci enclosed in a capsule (G. S. Woodhead) (Fig. 7).

The cocci are often named according to their function, as, for example, "pyogenic," or pus-forming. Cocci may be named according to the color of the culture. The name may embody the form, arrangement, color, and function; for instance, Staphylococcus pyogenes aureus signifies a round, golden-yellow micro-organism, which arranges itself with its fellows in the form of a bunch of grapes, and which produces pus.

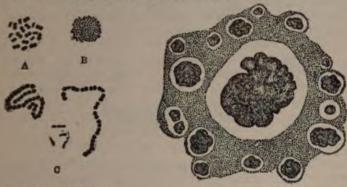


Fig. 8.-Forms of cocci.

Fig. 9.-Zoōglea (Ball).

The bacilli are long, staff-shaped organisms. Long, delicate, jointed bacilli having wavy outlines are known as leptothrix forms. Chain-like bacilli are called streptobacilli. Bacilli give origin to many surgical diseases.

Dichotomy or Branching.—It is very seldom that a side bud appears upon

bacteria except in the bacteria of tuberculosis and diphtheria.

Pseudodicholomy is by no means unusual. It occurs when one end of a bacillus grows by the end of the adjacent bacillus or when a bacillus in a chain divides in a line parallel to the chain and thus begins another chain (Fig. 10).

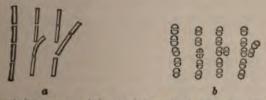


Fig. 20.—Pseudodichotomy. a, In bacilli; b, in streptococci (Lehmann and Neumann).

Multiplication of Bacteria.—Bacteria multiply with great rapidity when placed under suitable conditions. They can multiply by transverse fasion or by spore-formation. Some bacteria multiply by both methods. In fission, or segmentation, a bacillus undergoes an increase in size and length; a coccus does not increase in size but slightly elongates. In either case about the middle of the cell a transverse constriction begins, which deepens until the cell has divided into two parts, each of which soon grows as large as its parent (Figs. II, Iz). As a rule, the micro-organisms separate after division of the cell; but they may not do so; and if they do not separate, the special grouping receives a particular name (diplococci, streptococci, etc.). If the division is invariably in the same direction, and if the new cells remain in contact, strepto-

cocci or streptobacilli are formed. Tetracocci and sarcinæ are formed when a number of cocci "divide in two or three successively vertical directions" ("Clinical Bacteriology," by Levy and Klemperer), forming four quadrants (tetracocci) or eight octants (sarcinæ). All cocci and some bacilli multiply by fission.



Fig. 12.-Divisions of a bacillus (after Macé).

If segmentation of a single cell and the growth to maturity of its products require one hour (it really takes place in less time, the cholera bacillus requiring but twenty minutes to divide), a single cell in a single day, if the conditions for increase were ideally favorable, would have 16,000,000 descendants, and in three days the mass of new cells would weigh 7500 tons (Cohn). In order, however, for such enormous multiplication to occur conditions would have to be absolutely favorable to the cells, and conditions are never absolutely favorable. Were it otherwise, all other forms of life would be destroyed. During growth in a culture medium inhibitory substances are formed, and these substances are detrimental to the bacteria themselves and to all bacteria of the same type. Such substances are known as autotoxins (Conradi and Kurpjuweweit, in "Muenchen. med. Woch.," No. 32, September 12, 1905). In a culture of cholera bacilli the number of living microbes begins to lessen after twenty-four hours, and after forty-eight hours the diminution is distinct.

Spores.—A spore is a germ, and corresponds with the seed of a plant.

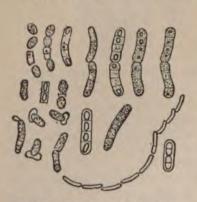


Fig. 13.-Sporulation (after De Bary).

Some bacilli, a few spirilla, and it may be sarcinæ, multiply by spore-formation. Cocci do not undergo spore-formation after the manner of bacilli, though some observers maintain that cocci occasionally undergo an alteration that makes them very resistant to any destructive influences. When sporeformation is about to occur in a bacillus, a point of cloudiness or an area of bright refraction appears in the protoplasm and the cell generally elongates. When a row of cells sporulate, the segments, each of which contains a lustrous area or a region of cloudiness, look like parts of a necklace of beads (Fig. 13).

The spore enlarges, the cell membrane bursts, and the young bacillus emerges

through the opening. A cell usually contains but one spore, which may be situated at the end of the cell (endspore) or in the middle of the cell (endospore). Sometimes a single cell contains several spores. If an endspore exists, the end of the cell containing the spore is swollen or club-shaped (drumstick bacterium). If an endospore exists, the cell becomes spindle-shaped (clostridium). When multiplication is by a single endospore, the bacillus does not elongate. When multiplication takes place by a process of combined spore-formation and fission, the mother-cell divides into a number of daughter-cells, which are called arthrospores. Organisms which when active multiply by fission take on spore-formation when subjected to certain conditions.

Spore-formation tends to occur when bacilli are about to die for want of nourishment or when there is an excess of oxygen present. The spore has a dense envelope or covering which is very resistant to destructive agents. So resistant is the covering that twice the amount of heat is necessary to kill a spore as to kill an active adult cell. Spores when placed under conditions unfavorable for development may remain inactive for an indefinite period, just as seeds remain inactive when unplanted. When spores encounter favorable conditions, they at once develop into adult cells, just as seeds develop when planted. It seems probable that spores occasionally remain dormant in the human body for long periods, and finally awaken into activity because of injury or disease of the tissue in which they lie.

Chemical Composition of Bacteria.—The protoplasm of bacteria consists of water, salts, albuminous material, extractives soluble in alcohol,

and extractives soluble in ether.

Life-conditions of Bacteria.—In order to grow and to multiply, bacteria require a suitable soil and the favoring influences of heat and moisture. The soil demanded consists of highly organized compounds rather than crude substances, and slight modifications in it may prove fatal to some forms of bacterial life, but highly advantageous to others. Some organisms require albuminous matter, others need carbohydrates; they all require water, carbon, nitrogen, oxygen, hydrogen, and certain inorganic materials, especially lime and potassium (Woodhead). All organisms require water. If dried, no micro-organisms will multiply, and many forms will die. The fluids and tissues of the individual may or may not afford a favorable soil for the germs of a disease, or, in the same person, may afford it at one time and not at another. Some individuals seem to possess indestructible immunity from, and others are especially prone to, certain bacterial diseases, and these immunities and predispositions may be hereditary. The Japanese show high immunity to scarlet fever and negroes to yellow fever. Drunkards are predisposed to pneumonia. Some families exhibit high susceptibility to scarlet fever. Negroes are very susceptible to tuberculosis and small-pox. Impairment of health, by altering some subtle condition of the soil, may make a person liable who previously was exempt. The insane are predisposed to infections. Injury or disease of a tissue may increase local liability.

Again, some bacteria which under normal conditions are harmless may become virulent under certain conditions. Colon bacilli, which under normal conditions seem to be putrefactive organisms inhabiting the intestine, may attack a point of least resistance in the intestine itself; this point being established by congestion, strangulation, inflammation, or injury, and descendants

of the bacteria which attacked the point of least resistance may become so virulent that they can live and develop in tissues distant and apparently normal and cause disease in them.

The presence of oxygen influences microbic growth. Most organisms thrive best when exposed to the oxygen of the air, and they are known as aërobic. The term anaërobic is employed to designate organisms that can grow and multiply and produce particular products only when air is absent, free oxygen being fatal to them. Tetanus bacilli and the bacilli of malignant edema are anaërobic. An organism which grows best in air but can grow when free oxygen is excluded is called a jacultative-aërobic bacterium. It may need oxygen; but if it does, it is able to obtain it from the tissues when air is excluded. A sensitive organism which dies when the amount of oxygen is even slightly diminished is called an obligate-aërobic bacterium. Most microbic diseases in man are due to facultative-aërobic bacteria.

Effect of Motion, Sunlight, the X=rays, Radium, Cold, and Heat. -The majority of fungi grow best when at rest; violent agitation retards the growth of some. Sunlight antagonizes the growth of certain bacteria, especially tubercle bacilli and the bacilli of typhoid fever. It is claimed by some that the x-rays retard bacterial growth. Radium rays are bactericidal. Temperature influences bacterial growth. Some organisms will grow only within narrow temperature limits, while others can sustain sweeping alterations, but most grow best between the limits of from 86° to 104° F. Freezing renders bacteria motionless and incapable of multiplication, but it does not kill them; they again become active when the temperature is raised. Prudden showed that typhoid bacilli can live in ice one hundred and three days. The absurdity of employing cold as a germicide is evident when the fact is known that a temperature of 200° F. below zero is not fatal to germ-life, cell-activities by such a temperature only being rendered dormant. Bacteria have been placed in hermetically sealed tubes and the tubes immersed in liquid air for seven days. The germs were thus subjected to a temperature of -190° C., but there was no change produced in their virulence (A. MacFayden and S. Roland, in "Lancet," March 24, 1900). High temperatures are fatal to bacteria; moist heat is more destructive than dry heat, and adult cells are more easily killed than spores. A temperature less than 212° F. will kill many organisms, and boiling will kill every pathogenic organism that does not form spores. Some spores are not destroyed after prolonged boiling, and some will withstand a temperature of 120° C. As a practical fact, however, boiling water kills in a few minutes all cocci, most bacilli, and all pathogenic spores; though the spores of anthrax, tetanus, and malignant edema are killed with more difficulty than are the spores of other bacteria.

Effect of Bacteria upon Bacteria.—Some bacteria are antagonistic to others, some are synergistic to others. The streptococcus of erysipelas is antagonistic to the bacillus of anthrax and also to syphilis and tuberculosis. The growth of some microbes in culture media makes a soil favorable or unfavorable for other microbes, and the same process may occur in the human body. Influenza renders the lungs prone to infection with pneumococci. Saprophytes on mucous surfaces are antagonistic to certain pathogenic bacteria. We are not yet able to cure a microbic disease by inoculating the sufferer with antagonistic microbes, on the principle of sending a thief to catch a thief.

Latent Bacteria.—Sometimes pathogenic organisms remain latent in the body for a considerable time. They are not destroyed, but produce no symptoms, or only local symptoms, possibly because the individual is immune for the time being. Pneumococci, staphylococci, and typhoid bacilli may become latent. Tubercle bacilli may remain long latent in a lymph-gland or in any old area of caseation.

Latent bacteria may take on active growth when the tissue containing them is damaged by injury or disease. I have seen active disease arise in an apparently cured and stiff tuberculous joint as a result of forcibly breaking up adhesions. An attack of bronchitis may light up an old and latent area of pulmonary tuberculosis. The administration of ether or chloroform by inhalation may render active an inactive tuberculous focus in the lung. A partial or incomplete operation on a quiescent tuberculous lesion is apt to be followed by active spread and may result in wide dissemination of disease.

Mixed Infection.—A fact of practical importance to the surgeon is that an area infected by one form of micro-organism may be invaded by another form. This is known as a mixed infection, and consists in a primary infection with one variety of organism, and a secondary infection with another, or in an infection at the same time with different micro-organisms. Mixed infection is especially common on surfaces exposed to air and wound infection is usually mixed. Koch found both bacilli and micrococci in the same lesion of tuberculosis. A soil filled with pneumococci favors the growth of pus cocci and tubercle bacilli. Tuberculous or syphilitic lesions may be attacked by erysipelas. Chancre and chancroid can exist together. A syphilitic ulcer is a good culture-soil for tubercle bacilli (Schnitzler). Suppuration in lesions of tuberculosis is due to secondary infection with pus organisms. Occasionally in empyema and other conditions due to pus organisms the diseased process ceases to be active, the pyogenic bacteria having lost much of their virulence, but a mixed infection with some germ usually harmless may break down surrounding barriers, intensify the virulence of bacteria, and aggravate the disease into an acute outburst. When secondary infection occurs the primary infection may remain virulent, may be mitigated in intensity, may be destroyed, or may be disseminated.

Intra-uterine or Placental Infection.—The infection of the embryo by the diseased ovum or the diseased sperm-cell occurs only in syphilis. Such an embryo is diseased at the first moment of life. The direct transmission of bacteria from parent to fetus is a problem still in course of solution. Certain it is that some diseases may follow the transmission of the micro-organism through the septum of separation between the circulations of the mother and child. Placental transmission may occur in syphilis, scarlatina, pneumonia, anthrax, measles, pyogenic conditions, and tuberculosis (Hektoen). Few cases of congenital tuberculosis have been reported, but Rosenberger has recently shown the bacilli in the umbilical vein from the placenta of a tuberculous mother. A child of a tuberculous parent may not be born tuberculous, but may have weakened tissue-cells that easily fall a prey to the tubercle bacillus when it reaches them by any avenue. Placental transmission of bacteria is favored by disease or injury of the placenta.

Chemical Antiseptics and Germicides and Aseptic Agents.—It is necessary to make a distinction between deodorizers, antiseptics, and germicides, although the two latter terms are usually regarded as being interchangable. In the methods of antiseptic surgery we use germicides.

A deodorizer is an agent which destroys an offensive odor. It is true that an offensive odor may be due to microbic growth. It is also true that nasty odors may prove injurious to those who inhale them. But, nevertheless, the odor is the result of microbic action, and destroying an odor does not render harmless the bacteria which caused it. Charcoal is a well-known deodorizer.

An antiseptic is an agent which retards or prevents putrefaction. It acts by weakening or killing saprophytic organisms, but is not fatal to spores.

A germicide or disinfectant is an agent which is fatal to adult bacteria and spores. The destruction of the germs of disease on the skin, in clothing, in excreta, in a wound, etc., is known as disinfection. Disinfection of the skin, of a wound, of dressings, or of instruments is called also sterilization.

Antiseptics and germicides should not be used in surgically clean wounds. Repair will occur more quickly if they are not used. Tillmanns has pointed out that when antiseptics are used cell-division begins late and progresses slowly. Germicides are not efficient in fatty tissue, as bacteria surrounded with oil cannot be reached by the drug, and the chemical is irritant and apt to induce fat necrosis (Haenel, in "Deutsch. med. Woch.," 1895, No. 8).

Corrosive Sublimate.—Many chemical agents will kill bacteria, one of the most certain of them all being corrosive sublimate. Koch showed that corrosive sublimate is an efficient test-tube germicide when present in the proportion of only 1 part to 50,000. It is used in surgery in strengths of 1 part of the salt to 1000, 2000, 3000, or more parts of water. Badly infected wounds are occasionally irrigated with solutions of a strength of 1 to 500. Contact with albumin precipitates from a solution of corrosive sublimate an insoluble albuminate of mercury which forms a white layer upon the surface of the wound, is not a germicide, and prevents deep diffusion of the mercurial fluid. In surgical operations by the antiseptic method the mercurial salt should be combined with tartaric acid in the proportion of 1 to 5, which combination prevents the formation of the insoluble albuminate of mercury.

But though corrosive sublimate under certain conditions is extremely powerful, it is not always absolutely reliable. Many spores are very resistant to its action. Even a 1 per cent. solution of bichlorid of mercury is not certainly destructive to the spores of anthrax. Geppert tells us that anthrax-spores may be active after a twenty-five hour immersion in a 1:100 solution of sublimate (Schimmelbusch). In the presence of hydrogen sulphid corrosive sublimate is useless, inert and insoluble sulphid of mercury being precipitated; hence corrosive sublimate is without value as a rectal antiseptic; in fact, Gerloczy has proved that a concentrated aqueous solution of sublimate will not disinfect an equal quantity of feces. Corrosive sublimate contained in dressings after a time undergoes decomposition and ceases to be a germicide. It is not germicidal in fatty tissues because it is unable to attack bacteria which are coated with oil. Corrosive sublimate is very irritating to the tissues and causes copious exudation. Hence, if an extensive wound has been irrigated with this agent, drainage must be employed to obtain exit for the wound fluid. In some wounds which have been irritated by corrosive sublimate the tissues seem to lose to a great extent their power of resistance to bacteria and infection may be actually facilitated by irrigation with bichlorid of mercury. In rare instances corrosive sublimate is absorbed and produces poisoning. In spite of these shortcomings and drawbacks it is a valuable aid to the surgeon and must be frequently used, especially upon the skin of the patient and the hands of the operator and his assistants. It should be dissolved in distilled water. Ordinary water causes a precipitate to form (common salt

prevents the formation of this precipitate).

Because of the fact that corrosive sublimate is poisonous and very irritant, it should not be used upon serous membranes. It is absorbed quickly from serous membranes and destroys the endothelial cells and should not be introduced into the pleural sac, into joints, or into the peritoneal cavity. It should never be put within the dura, and should not be applied, in strong solution at least, to mucous membranes. It should not be introduced into the rectum for three reasons: First, it is intensely irritant and causes pain and inflammation. Second, it is useless, being largely and promptly converted into insoluble and inert sulphid of mercury. Third, a poisonous dose may be absorbed. Instruments cannot be placed in corrosive sublimate without being dulled, stained, and corroded. It is better to make the solution at the time it is needed, so as to have it fresh, for in old solutions much of the soluble corrosive sublimate has been converted into soluble oxychlorid of mercury, and the fluid has ceased to be germicidal. In order to make up fresh solutions use tablets, each of which contains about 71 grains of the drug-one of these tablets added to a pint of water makes a solution of a strength of 1 to 1000. Tablets which also contain ammonium chlorid are more soluble than those which contain corrosive sublimate only. Hot solutions of the drug are more powerfully germicidal than cold solutions. As corrosive sublimate is irritant, leads to profuse exudation, and may produce tissue-necrosis, it should never be introduced into an aseptic wound. In such a wound it can do no good and may do much harm.

Griffin, in Foster's "Practical Therapeutics," sets forth the strengths of

solutions applicable to different regions:

For disinfection of the surgeon's hands and the patient's skin, I: 1000; for irrigating trivial wounds, I: 2000; for irrigating larger wounds and cavities, I: 10,000 to I: 5000; for irrigating vagina, I: 10,000 to I: 5000; for irrigating urethra, I: 40,000 to I: 20,000; for irrigating conjunctiva, I: 5000; for gargling, I: 10,000 to I: 5000.

Corrosive Sublimate Poisoning.—Corrosive sublimate may be absorbed from a wound, a serous surface, or a mucous membrane, ptyalism and diarrhea resulting. The absorption of bichlorid of mercury may be followed by tramp in the limbs and belly, feeble pulse, cold skin, extreme restlessness, and even collapse and death. At the first sign of trouble withdraw the drug and

treat the ptyalism (page 334).

Lithiomercuric Iodid.—This material was prepared and tested by Dr. Rosenberger and Mr. England ("American Medicine," 1904, p. 1021). It is asserted that the iodid of mercury and lithium is more powerfully germicidal than corrosive sublimate, does not form inert albuminate when placed in a wound, and is not precipitated by alkalies. It is not nearly so irritant nor is it so poisonous as corrosive sublimate. I have given it an extensive trial in my clinic and am satisfied that it is superior to corrosive sublimate as a germicide, is less irritant, and is less poisonous. Its only objection is that it is more expensive.

Carbolic Acid.—Carbolic acid is a valuable germicide in the strength of from 1:40 to 1:20. It is certainly fatal to pus-organisms, but weak solutions fail to kill most bacteria and do not destroy spores. Unfortunately, this acid attacks the hands of the surgeon; consequently in the United States dilute carbolic acid is chiefly employed as a solution in which to place the sterilized operating instruments, or as a germicide to prepare the skin of the patient before the operation is performed.

Carbolic acid is very irritant to tissues, and carbolized dressings may be responsible for sloughing of the wound or dry gangrene (p. 197). Because of its irritant properties wounds which have been irrigated with it should be well drained. Carbolic acid, like corrosive sublimate, is inert in fatty tissues.

Pure carbolic acid is a reliable disinfectant for certain conditions. It is used to destroy chancroids, to purify infected wounds and abscess cavities, to disinfect the medullary cavity in osteomyelitis, to stimulate granulation after the open operation for hydrocele, or to purify sloughing burns or ulcerated areas. The pure acid rarely produces constitutional symptoms, but it occasionally causes sloughing. Its application causes pain for a moment only, and then analgesia ensues. Even dilute solutions of carbolic acid greatly relieve pain when applied to raw surfaces. The local action of carbolic acid can be at once antidoted by the application of alcohol (Seneca D. Powell). When carbolic acid is applied to a wound, the area about the wound should first be moistened with alcohol. After the application of pure carbolic acid to the interior of a joint, a wound, the medullary canal, or an infected area, the surgeon should wait about one minute and then apply alcohol.

Dilute carbolic acid acts more slowly and less certainly than corrosive sublimate. It requires twenty-four hours for a 5 per cent. solution to kill anthrax spores. Pus or blood (albuminous matter) greatly weaken the germicidal power of carbolic acid, and fatty tissue cannot be disinfected by it. It is not even the best of agents in which to place instruments, as it dulls them. After operation upon the mouth it may be used as a wash or gargle, I to 2 per cent. being a suitable strength. It is used sometimes to irrigate the bladder and often to cleanse sinuses, but is not employed in the peritoneal cavity, the pleural sac, the rectum, or the brain. It is occasionally injected into tuberculous joints. Carbolic solution should never be used in clean wounds.

Carbolic Acid Poisoning.—Carbolic acid is readily absorbed, and may thus produce toxic symptoms. Absorption is not uncommon when the weaker solutions are used, but seldom occurs when a wound has been brushed over with pure acid, because the pure acid at once forms an extensive zone of coagulated albumin, which acts as a barrier to absorption. One of the early indications of the absorption of carbolic acid is the assumption by the urine of a smoky, greenish, or blackish hue. This hue appears a little time after the urine has been voided, whereas the smoky hue of hematuria is noted in urine at once after it has been passed. The condition produced by carbolic acid is known as carboluria, and examination of such urine shows a great diminution or entire absence of sulphates when the acidulated urine is heated with chlorid of barium. The diminution of precipitable sulphates is explained by the fact that these salts are combined with carbolic acid, forming soluble sulphocarbolates (Griffin). Such urine is apt to contain albumin. If during the use of carbolized dressing or the employment of carbolic solutions the urine becomes

smoky, the use of the drug in any form must be at once discontinued, otherwise dangerous symptoms will soon appear. These symptoms are subnormal temperature, feeble pulse and respiration, muscular weakness, and vertigo. If death occurs, it is due, as a rule, to respiratory failure. The treatment of slow poisoning by carbolic acid consists in at once withdrawing the drug, giving stimulants and nourishing food, administering sulphate of sodium several times a day and atropin in the morning and evening.

Saline Solution.—Sodium chlorid solution of normal strength (0.7 of 1 per cent.) does not damage the cells of serous surfaces or of a wound hence it is used as an irrigating fluid, and it is the best fluid for such a purpose. In intravenous infusion, in shock or hemorrhage it is very valuable. It does not damage the blood-corpuscles as plain water does. It is, however irritant to the kidneys, when used by hypodermoclysis or intravenous infusion; hence if the kidneys are diseased saline fluid of one-half normal strength should be used for either of the latter purposes. Normal salt solution is prepared as follows: A quart of water is filtered and sterilized and in this 1½ drams of table salt are dissolved, and the fluid is again boiled (see pp. 465 and 467).

Thiersch's Fluid.—This sluid is used upon mucous and serous surfaces and is employed to irrigate wounds. It is non-toxic and non-irritant. It consists of 1 grain of salicylic acid and 6 grains of boric acid to 1 ounce of sterile water.

Alcohol.—Alcohol is a germicidal agent, which is most powerful when of the strength of 70 per cent. It may be used on the hands or the skin of the patient, of a strength of from 70 to 95 per cent. and may be used plain or mixed with corrosive sublimate, of the strength of 1 part of corrosive to 1000 parts of alcohol. Pure alcohol is used to arrest the local action of pure carbolic acid.

Boiled Water.—Is used to dissolve antiseptic materials; to inject by hypodermoclysis; to irrigate wounds, mucous cavities or serous surfaces, and as a fluid in which to keep instruments during the operation. It damages somewhat the tissue-cells of the surface of a wound and injures the cells of serous surfaces, hence for irrigation salt solution is to be preferred.

Creolin, which is a preparation made from coal-tar, is a germicide without imitant or toxic effects. It is less powerful than carbolic acid, but acts similarly and is used in emulsion of a strength of from 1 to 5 per cent., and does not imitate the skin like carbolic acid.

Peroxid of hydrogen is an excellent agent for cleansing a purulent or putrid area, but it is never applied to an aseptic wound. It is prepared in a to-volume solution, which should be diluted one-half or two-thirds before using. A 30 per cent. solution is known as perhydrol. It probably destroys the albuminous element upon which bacteria live, and thus starves the fungi. When proxid of hydrogen is applied to a purulent area ebullition occurs, liberated oxygen bubbling up through the fluid and the pus being oxidized. The permid reaches every cranny and diverticulum containing pus. The permid reaches every cranny and diverticulum containing pus. The permid of hydrogen is not fatal to tetanus bacilli; in fact, tetanus bacilli can be cultivated in a strong solution of it. It is very valuable as a mouth-wash to cleanse the mouth before and after operations in the oral cavity. Some surgeons use it to wash out appendicular abscesses (R. T. Morris). It must not be injected into a deep abscess in any region unless a large opening exists, as otherwise the

evolved gas may tear apart structures, dissect up the cellular tissue, and spread infection. The use of peroxid should not be too long continued, for if used for a considerable period it makes the granulations edematous and retards healing.

In fact, its continued use may actually prevent a sinus closing.

Iodoform.—Iodoform is largely used by surgeons in spite of the fact that laboratory workers have assured us it is not truly a germicide as bacteria will grow upon it. Clinical evidence, however, is in its favor and surgeons long ago concluded that it at least hinders the development of bacteria, directly antagonizes the action of the toxic products of germ-life, and stimulates the production of connective tissue. It is of the greatest value when applied to putrid foci, suppurating areas, and tuberculous processes. In putrid foci it probably combines with toxins and renders them less poisonous or even inert.

It attenuates the virulence of pus cocci and organisms of putrefaction. It renders its greatest service in tuberculous processes and is infinitely more powerful when oxygen is excluded than when it is present. The laboratory workers who condemn it have in many cases used nutrient material in which it does not dissolve (P. F. Lomry, "Archiv für klin. Chir.," 1896). D. B. Heile ("Proceedings of the German Surgical Congress of 1903") insists that iodoform is a valuable germicide if oxygen is excluded. He says, if iodoform is mixed with tissue juice, oxygen being excluded, the mixture becomes powerfully germicidal, even to streptococci, in from three to five days, although, as he maintains, neither constituent of the mixture when alone is germicidal. Tissue juice decomposes iodoform, liver juice decomposing it most rapidly, brain and fat decomposing it slowly. Granulation tissue decomposes it and tuberculous

granulation tissue acts upon it most rapidly.

The conclusion of Heile is that this study confirms the clinical observation that iodoform is valuable in cavities but not in free surfaces. My own belief is that it is more valuable in cavities than upon free surfaces, but when we are dealing with putrefactive areas, even on free surfaces, it is of great value. Heile maintains that when iodoform decomposes on a free surface it sets free I, which is not a powerful germicide. When it decomposes in tissue juice it forms a powerful germicide which is rendered inert by oxygen. Clinically, no real substitute for iodoform has yet been found. It can be rendered sterile by several washings with a solution of corrosive sublimate. It need not be applied to clean wounds, but the powder is very useful when dusted into infected wounds. It prevents wound discharges from decomposing and distinctly allays pain. Gauze impregnated with iodoform is used to keep abscesses open after evacuation, to drain the belly after certain operations, to pack aside the intestines and prevent their infection during some abdominal operations, and as packing to arrest intracranial hemorrhage. Iodoform gauze will drain serum well, but will not drain pus. In fact, it blocks up a pus-cavity, and if retained long leads to the collection of purulent matter behind and about the supposed drain. If used in an abscess, it must be removed in twenty-four or thirty-six hours. Tuberculous joints and cold abscesses are injected with iodoform emulsion, which is made by adding the drug to sterile glycerin or olive oil. The emulsion contains to per cent. of iodoform. A solution in ether of a strength of 10 per cent. may be used to inject the cavity of a cold abscess, but it is dangerous, may rupture the wall, and is more apt to produce poisoning than is the emulsion. Iodoform wax is used to fill cavities in bone (p. 509).

Iodoform-poisoning.—The drug must be used with some caution. Absorption from a wound sometimes happens, producing toxic symptoms. These symptoms are frequently misinterpreted, being usually attributed to infection. R. T. Morris has pointed out that in iodoform-poisoning the wound seems to be in excellent condition, whereas in sepsis the wound is unhealthy. The symptoms in some cases are acute and arise suddenly, and consist of hallucinatory delirium, nausea, fever, watery eyes, contracted pupils, metallic taste in mouth, yellowness of the skin and eyes, an odor of iodoform upon the breath, the presence of the drug in the urine, the outbreak of a skin eruption resembling measles or one which is erythematous, vesicular, bullous, or petechial. There is often nephritis and always excessive loss of flesh and strength. Patients with such acute symptoms usually pass into coma and die within a week. Such attacks are most apt to arise in those beyond middle life (see Gerster and Lilienthal, in Foster's "Practical Therapeutics"). Iodin can be recognized in urine by adding a few drops of commercial nitric acid and a little chloroform. When the mixture is shaken the chloroform will take up the free iodin and become purple, and on standing the purple layer will settle to the bottom of the tube. Another method is as follows: Put a little urine in a saucer, add a little calomel, and stir. If the urine contains iodoform a brown color will be noted (R. T. Morris). The finding of iodin in the urine, however, is not proof that the patient is poisoned. We may find it when no sign of poisoning exists. In chronic cases of iodoform-poisoning the first symptoms usually observed are moroseness, bewilderment, and irritability, followed by depression, with unsystematized persecutory delusions, delirium, coma, and even death.

In systemic poisoning by iodoform, discontinue the use of the drug, sustain the strength of the patient, and favor the elimination of the poison.

Iodoform sometimes produces greal local irritation of the cutaneous surface, the dermatitis being eczematous or else being manifested by crops of vesicles filled with turbid yellow serum or even bloody serum. These vesicles rupture and expose a raw oozing surface, looking not unlike a burn. The dermatitis usually exists only in the region with which iodoform was in contact, but in some cases it spreads widely. The use of the drug must be at once abandoned, for to continue it will not only increase the dermatitis, but may produce constitutional symptoms. Wash the vesiculated area with a stream of normal salt solution to remove iodoform, open each vesicle, and dress the part for several days with gauze wet with normal salt solution. After acute inflammation ceases apply zinc ointment or cosmolin.

Aristol is an odorless iodin compound used by some as an antiseptic dusting-powder.

Loretin is an antiseptic powder which is odorless, germicidal, non-irritant, and which is said to be non-toxic.

Europhen is a powder containing iodin, and the iodin separates from it slowly when the powder is applied to wounds or burns. It does not produce toxic symptoms readily, if at all, and is a valuable substitute for iodoform. It is used especially in the treatment of ulcers and burns.

Nosophen is a pale yellow powder containing 60 per cent. of iodin. Its bismuth salt is known as antinosin. Nosophen is not toxic, is free from odor, and is the best of the substitutes for iodoform.

Acetanilid is frequently used as a substitute for iodoform. It is of value

when applied to suppurating, ulcerating, or sloughing areas, but it does not benefit tuberculous conditions. Sometimes absorption takes place to a sufficient extent to cause cyanosis, sweating, and weakness of the pulse and respiration. If cyanosis arises, suspend the administration of the drug and administer stimulants by the stomach.

Airol is a substitute for pure iodoform, and is composed of gallic acid,

bismuth, and iodoform. It is non-irritant and non-toxic.

Among other powders we may mention iodol, amyloform, subiodid of bismuth, and dermatol or subgallate of bismuth.

Silver is a valuable antiseptic. Halsted and Bolton have shown that metallic silver exerts an inhibitive action upon the growth of micro-organisms and does not irritate the tissues. Credé has also demonstrated the same facts. These statements indicate one great reason why silver wire is such a useful suture-material. Halsted is accustomed to place silver foil over wounds after they have been sutured, and Credé employs as a dressing a fabric in

which metallic silver is intimately incorporated.

Credé considers silver lactate (actol) an admirable antiseptic. It does not form an insoluble albuminate when introduced into the tissues and is not an irritant. Silver citrate (itrol) is said to be even a better preparation than silver lactate, and it is a useful dusting-powder. A preparation of metallic silver, known as colloidal silver or collargolum, is made. This preparation is soluble in water and in albuminous fluids. It is said to remain as metallic silver when in solution and to be powerfully germicidal. It certainly seems to cause temporary leukocytosis, but so do some other drugs which are not antagonistic to infections. It comes put up in 1- and 2-grain tablets. A solution of the strength of from 1 to 5 per cent. is used. In severe cases of sepsis some advocate injecting this solution into a vein which has been rendered prominent by applying a bandage above the elbow. The dose is from 1 to 2 grains of the drug. One injection or more may be given. I have never seen it do the slightest good and I believe that intravenous injections are dangerous. Some have given it subcutaneously, some by the mouth, others by enema. Subcutaneous injections are often very irritant and it is doubtful if the drug is absorbed from either the stomach or rectum. The most extraordinary claims have been put forth regarding the therapeutic value of collargolum. Its use has been advocated in the most diverse general infections. I believe it is of no real value. Its claims, in my opinion, have been shattered by the majority report of the committee of the American Medical Association (" Jour. Am. Med. Assoc.," March 13, 1909). Crede's ointment of silver, I believe, is of use in infections of the skin and lymphatic vessels. I have used it repeatedly in such cases. In a child, 15 grains, in an adult, 45 grains of the ointment are rubbed in the skin at one time, and the rubbing should be kept up from ten to thirty minutes. There is said to be no risk of argyria. Protargol is a silver salt much used in gonorrhea. A solution in water is made. It is not precipitated by albumin, alkalies, nor acids. In gonorrhea a 1 to 5 per cent. solution is used. Argyrol is a new and valuable preparation of silver which I have used frequently with much satisfaction. It is known as silver vitelline, is not irritant, and contains 30 per cent. of metallic silver. It is not precipitated by albumin. In a strength of 5 per cent, it is a very useful injection for gonorrhea, as it has powerful gonococcidal properties. In some types of chronic cystitis several

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drams of a 3 per cent. solution may be injected into the bladder from time to time, and much stronger solutions can be used with safety. Inflamed mucous membranes may be painted with a solution of a strength of from 20 to 50 per cent. A sinus or a sluggish area of granulation may be stimulated by touching with a solution of a strength of from 25 to 50 per cent. I have found it of much service in sinuses.

Formaldehyd, or formic aldehyd, has valuable antiseptic properties. Formalin is a 40 per cent. solution of the gas in water. Solutions of this strength are very irritant to the tissues, but 1 per cent. solutions can be used to disinfect wounds. A solution of a strength of 0.5 per cent. is used to irrigate sinuses, tuberculous areas, abscess-cavities, and suppurating joints. A strong solution is used to asepticize chancroids and other ulcers. A 2 per cent. solution disinfects instruments. The vapor of formalin can be so applied as to disinfect wounds, and Wood suggests its employment in septic peritonitis as a means of disinfection after the abdomen has been opened. The vapor of formalin thoroughly disinfects catheters.

Formalin-gelatin was introduced by Schleich as an antiseptic powder. The commercial preparation is known as glutol. When applied to a clean wound it gives off formalin and keeps the wound aseptic. When it is applied to a sloughing surface it will not give off formalin unless it is mixed with pepsin and hydrochloric acid. Formalin-gelatin has been used to replace

bone-defects.

Lysol is a clear, brownish, oily fluid with an odor like creasote. It is a valuable germicidal agent. It is saponified phenol and is used in a solution of a strength of from 1 to 3 per cent. It does not attack the hands like carbolic acid and is much less poisonous.

Mustard is an excellent emergency germicide. Its value has been demonstrated by Roswell Park, who uses a mixture of soap, cornmeal, and mustard flour to scrub the surgeon's hands or the patient's skin. I have used it repeatedly with entire satisfaction. Mustard removes the odor of

decay at once.

Commercial gasolene is used by Riordan and others to clean wounds and ulcers, and to prepare the field of operation. Its vapor is so inflammable that the material must not be used when an artificial light is necessary, and it is used only in the daytime and on free surfaces where evaporation is rapid. It is sterile, non-irritant, and on evaporation leaves a dry, clean surface.

lodin.—This drug was strongly endorsed by the late Prof. Nicholas Senn ("Surgery, Gynecology, and Obstetrics," July, 1905). He regarded it as the most powerful and the safest of antiseptics, and claimed that in solutions of a strength of 1 per cent. it is non-irritant and causes a protective phagocytosis. It may be used in great dilution or the tincture may be applied to an infected wound in the same manner as is pure carbolic acid; a method advocated by Carl Beck. In dilute solution it is used to irrigate sinuses. The proper dilution for irrigation of a sinus is obtained when the tincture is diluted to the color of sherry wine.

Nucleins, especially protonuclein, possess germicidal powers. Nuclein is composed of nucleinic acid and proteid material. When injected hypodermatically and to a less degree when taken by the mouth it increases the germicidal lower of the blood-serum, causes leukocytosis and increased phagocytosis and

thus prevents or opposes infection. Mikulicz has used nucleinic acid to increase vital resistance as a preliminary to operation (page 42). A 1 per cent. solution of nucleinic acid is on the market. This acid is made from yeast. The dose of this preparation is from  $\mathfrak{M} x$  to lx, hypodermically, once or several times a day. *Protonuclein* probably contains nucleinic acid and is of some value when applied locally to areas of infection, particularly when sloughing exists.

Heat.—The best germicide is heat, and the best form in which to apply heat is by means of boiling water (which is even better than steam). One can use boiling water upon instruments and dressings, but seldom upon a patient. Jeannel, of Toulouse, uses boiling salt solution in abscess-cavities, and some other surgeons employ steam or boiling water to disinfect the medullary canal in osteomyelitis. Nevertheless, boiling water is seldom applied to a patient, and in many cases a chemical germicide must be used.

Among other antiseptics and germicides of more or less value we may mention trichlorid of iodin, chlorid of zinc, chlorid of iron, salol, oxycyanid of mercury, fluorid of sodium, argonin, sugar, lannaiol, bichlorid of palladium (in very dilute solution), thymol, potash soap, salicylic acid, boric acid, sulphate of copper, arsenite of copper, camphor, eucalyptol, cinnamon, bromin, chlorin (as gas or as chlorin-water), cinnamic acid, permanganate of potassium or of calcium, chlorate of potassium, and oxalic acid. The surgeon before operating should always scrub his hands in a germicidal solution.

Distribution of Bacteria.—Microbes are very widely distributed in nature. They are found in all water except that which comes from very deep springs; in all soil to the depth of three feet; and in air, except that over the desert, over the open sea, and that about lofty mountains. Dust-free air does not contain them; the more dust, the more microbes, hence they are present in greatest number in the air of towns. There are more in narrow courts than in broad highways, more in crowded attics than in roomy apartments. Bacteria are present on and in the skin, in the alimentary canal, in the nose, mouth, and pharynx, and in the blood and lymph. As Adami points out, under normal conditions the bacteria which enter the blood are very quickly killed.

Microbes may be useful. Some of them are scavengers, and clean the surface of the earth of its dead by the process known as "putrefaction," in which complex organic matter is reduced to harmless gases and to a mineral condition. The gases are taken up from the air by vegetables, and the mineral matter is dissolved in rain-water and passes into the soil from which it came, there again to be food for plants, which plants will become food for animals. Other organisms purify rivers; others cause bread to rise; still others give rise to fermentation in liquors. Microbes may be harmful. They may poison rivers and soils; they may be parasites on vegetable life; they cause diseases of the growing vine, and also of wine; they produce the mould on stale, damp bread; they occasionally form poisonous matter in sausages, in ice-cream, and in canned goods; and they produce many diseases among men and the lower animals.

With so universal a distribution of these *fungi*, man must constantly take them into his organism. They are upon the surface of his body, he inhales them with every breath, and he swallows them with his food and drink. Most of them, fortunately, are entirely harmless; others cannot act on the

living tissues; but some are virulent, and these are generally, but not always, destroyed by the cells of the human body. The alimentary canal always contains bacteria of putrefaction, which act only upon the dead food, and not upon the living body; but when a man dies these organisms at once attack the tissues, and post-mortem putrefaction begins in the abdomen. Even pathogenic bacteria may persist for long periods in the tissues without causing illness in the host, but when such bacteria do persist, they may at any time and from a variety of causes become active in producing disease or when they pass from the host they may perhaps infect other people (see Typhoid Carriers,

page 37).

Welch long ago pointed out that the human skin normally contains the staphylococcus epidermidis albus, even after the most careful surgical cleansing. Dudgeon, in the Horace Dobell Lecture for 1908 ("Lancet," Dec. 5, 1908, "Latent Persistence and the Reactivation of Pathogenic Bacteria in the Body"), says that healthy organs may contain various bacteria, that the tissues of the fetus are sterile, but in childhood and adult life "bacteria are found in various parts of the human body; that staphylococcus albus can be cultivated from the human omentum in cases in which the peritoneal cavity is apparently healthy"; that pus cocci may persist for long periods in a scar; that virulent diphtheria bacilli may be "found in the throats of persons who have come in contact with diphtheria patients, but show no signs of the disease"; that the bacillus proteus is frequently found in the urine; that colon bacilli normally inhabit the intestinal tract and appendix and frequently exist in the urinary tract without giving rise to inflammation or symptoms of disease, and that typhoid bacilli tend notably to persist (page 37).

Koch's Circuit.—To prove that a microbe is the cause of a disease it must fulfil Koch's circuit. It must always be found associated with the disease; it must be capable of forming pure cultures outside the body; these cultures must be capable of reproducing the disease; and the microbe must again be found associated with the artificially produced morbid process.

Disease Production.—Pathogenic organisms cannot enter through the sound skin and the unbroken skin without causing the formation of lesions at the point of entrance. The sound skin is the very best antiseptic covering for tissue, as ordinary bacteria cannot pass it at all. Some bacteria by entering the ducts of cutaneous glands may cause disease. Disease-producing organisms which enter the body may reach the focus in which they act from outside of the body, entering by inoculation, inhalation, or ingestion. In most instances organisms which enter the body from without are rapidly destroyed. When they enter in large numbers, or when they are very virulent, or when the vital resistance of the individual is at a low ebb they cause disease. Bacteria my reach the region in which they become active from some other part of the body. Bacteria seldom dwell in the body long without inducing disease, but spores can lie dormant in the system for years. When bacteria or spores from some other part of the body reach a region of injury or disease they may become active; this area is a damaged and weakened part, in it the circulation is abnormal, it is a so-called point of least resistance (a locus minoris resistentiæ) which affords a nest for them to develop and to multiply, the cellular activities of the weakened part being unable to cope with the activities of the germs. Even large numbers of pathogenic organisms may induce no trouble in a healthy

man; but let them reach a damaged spot, and mischief is apt to arise. Kocher established subcutaneous bone-injuries in dogs, and these injuries pursued a healthy course until the animal was fed upon putrid meat, whereupon suppuration took place. This experiment proves that micro-organisms can reach a damaged area by means of the blood, and it enables us to understand how a knee-joint can suppurate when we merely break up adhesions, and how osteomyelitis can follow trauma when the skin is intact. A given number of organisms might produce no effect on a healthy man, whereas the same number might produce disease in an individual who was weak or ill-nourished, suffering from depression or fear, or debilitated by the habitual use of alcohol. The personal equation plays a great part in disease-production. Some individuals seem to be immune to certain diseases; and these immunities and liabilities may be hereditary or acquired, temporary or permanent.

Enzymes.—Bacteria contain and excrete ferments, and these ferments are known as enzymes. Bacterial ferments resemble pepsin and trypsin, the digestive ferments. The digestive ferments convert albumin into peptone, starch into sugar, and break up fat. When microbic infection of the tissues occurs the enzymes of the bacteria act upon the tissues just as the digestive ferments act upon the food, and form microbic albumoses. The enzymes are the weapons of micro-organisms. By means of these ferments bacteria not only prepare substances for assimilation, but seek to destroy antagonists and cell enemies. It is probable that enzymes when absorbed are frequently

productive of toxemia.

Toxins.—The action of pathogenic bacteria upon the tissues is of great importance. In the first place, they abstract from the blood, the lymph, and the cells certain elements necessary to the body,-as water, oxygen, albumins, carbohydrates, etc., - and thus cause body-wasting and exhaustion from want of food. In the second place, bacteria produce a vast number of compounds, some harmless and others highly poisonous. The symptoms of a microbic disease are largely due to the absorption of poisonous materials from the area of infection. These poisons may be formed from the tissues by the action upon them of the bacteria (true toxins and peptones) or may be liberated from the bodies of degenerating microbes (bacterial proteid or endotoxins). Bacteria contain and secrete ferments; and as albumoses are formed in the alimentary canal by the action of digestive ferments upon proteids, sugars, and starches, so microbic albumoses are formed by the action of microbic ferments upon tissues. Just as the albumoses formed in digestion are poisonous when injected, so the albumoses of microbic action are poisonous when absorbed. The albumoses of microbic action are called toxalbumins, and these albumoses often operate as virulent poisons to the body-cells.

A number of compounds formed by the microbic destruction of tissue are alkaloidal in nature. These poisonous alkaloids are readily diffusible and, many of them, very virulent. It is probable that every pathogenic organism has its own special toxin which produces its characteristic effects, although the effects are modified by the nature of the soil—that is to say, by the condition of the tissues. Again one micro-organism may produce several toxins. The absorption of toxins may be very rapid; for instance, the toxins of cholera may kill a man before the bacilli have migrated from the intestine. Brieger uses the term toxin to designate all of the poisonous products of bacterial action.

He divides toxins into alkaloidal or crystallizable and amorphous, the latter being called toxalbumins.

Ptomains.—By many writers the term "ptomain" is used to designate these toxins, but in reality a ptomain is a form of toxin produced by the action of saprophytic bacteria. A ptomain is a putrefactive alkaloid and a toxin is any poison of microbic origin. Among these putrefactive alkaloids may be mentioned tetanin, typhotoxin, sepsin, putrescin, tyrotoxicon, muscarin, and spasmotoxin. The poison which occasionally forms in cheese, ice-cream, sausage, and canned goods is composed of ptomains. Poisoning by any

putrid food is called ptomain-poisoning.

Leukomains must not be confounded with the above-mentioned bodies. Leukomains are alkaloidal substances existing normally in the tissues and not produced by bacteria, but arising from physiological fermentations or retrogade chemical changes. They are natural body constituents, in contrast to toxins, which are morbid constituents. Leukomaïns are found in expired air, saliva, urine, feces, tissues, and the venom of serpents. If not excreted, these bodies may induce illness, and when injected may act as poisons. Ordinary colds and some fevers result from leukomains; they play a great part in uremia, and when excretion is deficient the retained leukomains make the system an hospitable host for pathogenic bacteria. Sickness due to the retention and absorption of leukomains is known as auto-intoxication. Among leukomains may be mentioned adenin, hypoxanthin, and xanthin, allied to uric acid, and other substances allied to creatin and creatinin. The surgeon should never forget the possibility of harm being done by retained leukomains, and should endeavor to prevent auto-intoxication in all cases by keeping the skin, the bowels, and the kidneys active.

Immunity.—If a person cannot be infected with a certain disease, he is said to be immune to it. Some persons seem naturally immune to certain diseases (natural immunity). Immunity to some diseases may be produced artificially. When the body itself produces the materials which render it immune the immunity is called active. When immunity is produced by the introduction of substances artificially produced the immunity is called passive. It has long been known that when a person recovers from certain diseases he has become immune to the disease from which he suffered (acquired immunity). Immunity may be transitory, prolonged, or permanent. Acquired immunity may be compared to fermentation. When fermentation ceases, the addition of more ferment is without result. When a person recovers from certain diseases, the addition to his blood of more of the causative bacteria is also void of result.

Immunity was long believed to arise from the exhaustion of some unknown constituent of tissue necessary to the life of the bacteria. This theory was advanced by Pasteur. It has been abandoned because of the demonstration that though an animal may become immune to certain bacteria, these bacteria may continue to live in the host. It is true that when recovery ensues upon infections, as a rule, the causative bacteria disappear, but there are enough exceptions to this rule to invalidate the theory of Pasteur. It is well known that even for years after an attack of typhoid fever the bacilli may exist in the gall-bladder or the bone-marrow, or be passed in urine. A person apparently well, yet holding, for instance, in his gall-bladder infectious bacteria, is called a "bacterial carrier." From 1 to 2 per cent. of persons who have had typhoid

fever years ago pass bacilli in the stools, and such carriers are often responsible for the spread of the disease. Gregg ("Boston Medical and Surg. Jour.," July 16, 1908) reported the case of a typhoid carrier fifty-two years after recovery from typhoid. A theory proposed by Chauveau is known as the "retention theory," and is the opposite of Pasteur's "exhaustion theory." According to Chauveau, bacteria growing within the body leave as a legacy excrementitious material, and the accumulation and retention of excrementi-

tious products produce immunity.

Until very recently one set of investigators maintained that immunity depends upon the activity of certain body-cells which attack, consume, and destroy bacteria, this is the theory of phagocylosis (page 41). The other theory is founded on the claims of Nuttal and Buchner, that normal fresh blood-serum is germicidal, the power varying for different bacteria and being limited. A fixed amount of serum is capable of destroying a fixed number of bacteria of a certain variety. Vaughan and others stated that the germicidal agent is probably a nuclein furnished chiefly by the white cells and held in solution by the alkaline serum. This germicidal agent Buchner called "alexin" or defensive proteid, and explained immunity by its presence. This theory is known as the "humoral theory." According to this theory as originally maintained, when an animal is naturally immune to a bacterial disease it is assumed that the blood-serum and body fluids contain enough of this alexin to dissolve or destroy the bacteria. Neither method of defense is the only one. In all probability both phagocytosis and bacterial solution are occurring in the same patient at the same time, phagocytosis being impossible but for the serum and bacteriolysis being impossible without leukocytes.

Since the above theories were set forth it has been found that when an animal recovers from some bacterial diseases the blood-serum and body fluids contain new protective materials called, in general, antibodies. The toxin of bacteria stimulates body cells to the production of antibodies and antibodies bring the disease to an end and secure immunity. It is thus seen that the very poisons produced by bacteria cause the body cells to produce poison antidotes. The bacteria may be so virulent or the patient so susceptible that poison overwhelms the cells, antibodies are not formed in sufficient quantity, and death ensues. The cells may be badly poisoned and the patient may become very ill, and yet after a time the cells may regain enough vitality to furnish antibodies in sufficient quantity to bring about cure and to secure immunity. The bacteria may be so few in number or so attenuated in virulence or the cells of the patient may be so active that quantities of antibodies are quickly formed under mild stimulation, and the individual does not take the disease at all or takes it very

mildly.

The lytic or bacteriolytic antibodies or lysins destroy and dissolve bacteria. All bacteria are not susceptible to lysis, for instance, streptococci, tubercle bacilli, and pneumococci. When recovery ensues the causative bacteria usually but not always disappear (page 37). These lytic bodies are formed by the leukocytes, bone-marrow, spleen, and lymph-glands (Wasserman in "Berlin klin. Woch.," No. 4, 1898; and Levaditi in "Annales de l'Inst. Pasteur," 1904).

Agglutinins and precipitins gather in the blood-serum of an animal when the animal has been injected with bacteria or certain cells. When these antibodies appear in blood after an animal has been injected with bacteria they agglutinate and precipitate the bacteria injected. It is probable that agglutinins and precipitins are formed by the endothelium of vessel walls (Kraus and Schiffman in "Annales de l'Inst. Pasteur.," 1906). These materials only appear after certain infections.

Opsonins are materials which by attaching themselves to certain bacteria so alter the bacteria that they easily become the victims of phagocytosis (see

Phagocytosis, page 41).

Antitoxins are specific bodies secreted, as Roux says, by the body cells. They pass into the serum and body fluids. They fix and neutralize the bacterial toxin by combining with it, but do not dissolve, kill, precipitate, or agglutinate the bacteria. The first antitoxin to be discovered was that of diphtheria. The discovery was made by Behring in 1890.\* He found that if an animal is injected with gradually larger amounts of toxin of diphtheria the serum comes to contain an antitoxic material. Very soon after this discovery was announced Behring and Kitasato made a like discovery in regard to tetanus toxin. It was pointed out by Kitasato and Behring that animals can be rendered immune to tetanus by artificial means and that the blood-serum of immune animals will, if injected into other animals, render them immune, or perhaps cure the disease if injected into animals suffering from tetanus. The same statements were also proved to be true of diphtheria. Now many experimenters are endeavoring to find the antitoxin of each microbic disease for the purpose of using it therapeutically and also as a preventive agent.

In some infections soluble toxins are not formed and the body resistance depends largely on the formation by the bacteria of substances which finally,

when present in sufficient amounts, destroy bacteria.

Certainly one of the most important of modern discoveries is that certain substances introduced into the body cause a reaction which results in the formation of antibodies. Any material which causes antibodies to form is called an antigen. In the preceding section we have spoken of bacterial products as the antigens. But other antigens exist, for instance, blood-corpuscles and other cells, blood-serum, some vegetable poisons, and some animal poisons. Thought is now directed to treating bacterial diseases by the introduction of the proper antigen to produce lysins, opsonins, antitoxins, as the case may be. Steptococci produce no antigen which leads to lysin formation, but do produce antigens which lead to antitoxin and opsonin formation.

The subject is of enormous importance and is vastly complicated.

Ehrlich's Theory of the Mechanism of Immunity by Antitoxins.—Ehrlich's theory was advanced in 1898 and is generally accepted at the present time. "Ehrlich's theory of the mechanism of immunity is based upon Weigert's teaching of the process of tissue repair. It is a matter of universal observation that nature is prodigal in her attempts to repair an injury. This is shown in the healing process in an ordinary wound. A much larger amount of material is thrown out to bridge the chasm than is really utilized in the formation of new tissue. The presence of an excessive amount of new material is shown by the fact that the part is raised above the level of the surrounding sound tissue, and this excess is removed gradually as the new-formed tissue becomes stronger and stronger, until finally the wound is marked by a line of white scar-tissue, the excess gradually passing into the blood-current.

<sup>\* &</sup>quot;Deutsche Med. Wochenschrift," 1890, Nos. 49 and 50.

"Ehrlich believed that the mechanism of immunity was explainable on a similar basis. It had become evident from the experiments of Wasserman with the tetanus bacillus that its toxin had an especial affinity for the cells of the central nervous system. Experiments with other bacteria pointed to the fact that the toxins of different species of bacteria had an especial affinity for the cells of different organs of the body. When the amount of poison entering the body is sufficient to destroy the cells which have an especial affinity for it, these cells may be injured only to such an extent as to permit subsequent repair. In order to comprehend Ehrlich's hypothesis it is necessary to conceive the cells of the body as having a complex structure which may be stated diagrammatically as consisting of a central mass or nucleus from which radiate a number of 'lateral chains,' or bonds, each of which serves to bind the cell to other substances. In the case of the cells of the central nervous system one of these lateral bonds has an especial affinity for tetanus toxin and suffers destruction. The cell now finds itself in unstable equilibrium, and at once proceeds to repair the damage wrought. As in the case of tissue repair, the new material produced is far in excess of the required amount. The excess finds its way into the blood-current. This material now circulating in the blood-current has the same affinity for tetanus toxin as when united with the central mass of a cell as its lateral bond, and can, therefore, combine with tetanus toxin floating in the blood-current, thus preserving other cells from injury. The union formed between the lateral bond of the cell (which is really the antitoxin) and the tetanus toxin results in the formation of a compound which is physiologically inert. According to Ehrlich's idea, therefore, the antitoxin is simply the excess of lateral bonds floating in the blood-current. This substance can neutralize the effect of the tetanus toxin in a test-tube just as readily as it does within the body " (D. H. Bergey, "American Medicine," October 11, 1902).

Phagocytes.—It was generally believed after Metchnikoff's important discoveries that leukocytes were the agents which protected the body from infection. When other observers found that in blood-serum is material that damages or destroys bacteria, opinion swung to the view that the blood-serum contains the protective element, and that the leukocytes are simply scavengers and remove dead bacteria, but do not destroy living ones. It has recently been shown that under some circumstances leukocytes destroy living bacteria and under other circumstances they do not, and that the presence or absence of this property depends in most instances upon the presence or absence in the blood-serum of substances which act upon bacteria and render them susceptible to the phagocytic action of leukocytes. We say in most instances, not in all instances, because certain bacteria, for instance, influenza, bacilli are phagocytable without the presence of opsonic serum (Ludvig Hektoen, address in "Section of Physiology and Experimental Medicine, American Assoc. for Advancement of Science," 1908; "Science," Feb. 12, 1909). The existence of substances in the serum provocative of phagocytosis was demonstrated by Wright and Douglas in 1903, and they named them opsonins. If opsonins are present, they act upon bacteria, and render the bacteria susceptible to phagocytosis. (See Ludvig Hektoen in "Jour. Am. Med. Assoc.," May 12, 1906). Opsonins act upon bacteria and alter them, and the altered bacteria are easily eaten up by leukocytes. Very virulent bacteria resist phagocytosis

because they have little affinity for opsonin (Hektoen), and such virulent bacteria may grow in opsonic serum. The source of opsonins is not known, but serum normally contains "opsonins for many different bacteria" (Hektoen, in "Jour. Am. Med. Assoc.," May 12, 1906). When experiment determines the fact that an individual's leukocytes are highly phagocytic toward particular bacteria, we believe that a quantity of opsonin for that variety of bacteria is present, and we may say the individual has a high opsonic index as regards them. Under opposite conditions we say he has a low opsonic index. "The opsonic index of Wright with respect to a given bacterium is obtained by comparing the number of the bacteria taken up under the influence of the serum of the person or animal in question with the number taken up under the influence of the corresponding standard of normal serum under conditions that are as comparable as they possibly can be made" (Ludvig Hektoen, address in "Section of Advancement and Physiology and Experimental Medicine in Am. Assoc. for Science," 1909; "Science," Feb. 12, 1906).

The Process of Phagocytosis.—We have just seen how opsonins stimulate phagocytosis. The process of destruction of bacteria by cells is known as phagocytosis, and the destroying cells are called phagocytes. The cells active in phagocytosis are the endothelial cells of the blood-vessels, lymph-channels and lymph-spaces, and particularly the leukocytes. When infection occurs, the white blood-cells gather in enormous numbers at the seat

of disease, encompass and surround the bacteria, and build a barrier to prevent dissemination of the microbes and general infection of the organism. The force which draws leukocytes to a region of infection also tends to draw them to an area where there is cellular degeneration or death. This force is called positive chemiolaxis and is greatly stimulated by opsonins. In very virulent infections the leukocytes may fail to collect and may actually be repelled and scattered

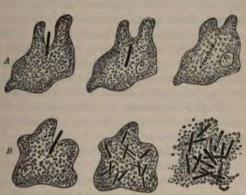


Fig. 14.—Phagocytosis: A, Successful; B, Unsuccessful (Senn).

under the influence of what has been called negative chemiotaxis. Phagocytes at the seat of infection try to eat up, carry away to a gland, and there digest and destroy bacteria. A battle royal occurs, the microbes fighting the bodycells with most active ferments and destroying the opsonic power of the blood-fiquor; the body-cells endeavoring to devour and destroy the bacteria (Fig. 14), in which effort opsonins give them aid. In some cases the bacteria win absolutely and the patient dies. In other cases they win for a time and overwhelm the system; but presently the body-cells, whose movements were inhibited by the poison, regain their activity and are then immune to the bacterial poison. It is probable that the materials thrown out by the white cells during the combat with the microbes tend to destroy bacterial products and to neutralize toxic products of tissue destruction. These materials, which

neutralize toxic products, are known as antitoxins (page 39). After the attack of disease has passed away the body-cells have been educated to withstand this poison, and new cells in the future retain this capacity; the weak cells were killed, the fittest survived, and the body fluids contain antitoxin. The new cells formed in the body are insusceptible to the poison and the individual is said to be insusceptible or immune. The theory of phagocytosis immunity assumes an educated white corpuscle and body-cell. This view originated with Sternberg, but it is usually accredited to Metchnikoff. Lankester gave us the term "educated corpuscle."

Artificial Stimulation of Phagocytosis.-When active hyperemia is induced by heat, when irritants are applied to an inflamed surface, or when an inflamed joint is treated by Bier's method of passive hyperemia, local leukocytosis is stimulated and phagocytosis becomes more active. Some ten years ago Issaëff affirmed that the introduction of certain materials, as salt solution, into the peritoneal cavity, leads, for a time, to great increase in the resistance to abdominal infection. This period of increased resistance he called the resistance period. It begins a few hours after the injection and terminates by the end of the fifth day. During this period the great increase in intraperitoneal leukocytes saves the animal from infection with bacteria, which would otherwise cause a dangerous or fatal inflammation. Mikulicz believed it possible to establish this resistance period before abdominal operations and was working on the problem just before his lamented death. Mikulicz used diluted nucleinic acid injected twenty-four to forty-eight hours previous to operation (Mikulicz, "Verhandl. d. 33. Congress d. Deutsch. Ges f. Chir.," 1904). Some surgeons have injected fresh warm horse-serum for the same purpose (Petie, Jayle, and Federmann; see "Le Presse Medicale," 1905). The agents used must not be of a nature to damage opsonins, for leukocytosis without plenty of opsonins would do no good.

Vital Resistance.—It is learned from the above that the vital resistance to infection depends in part upon germicidal and opsonic blood-liquor and in

part upon active leukocytes.

Vital resistance is increased by agents which cause active phagocytosis

(see nucleinic acid, page 34) without destruction of opsonins.

Anything that lessens the germicidal and opsonic power of blood-serum or the phagocytic activity of corpuscles lessens vital resistance. Among these causes are ill health, worry, unhygienic life, chronic drug intoxications, chronic visceral diseases, diabetes, Bright's disease, gout, rheumatism, violent and sudden fluctuations of temperature, and the creation of points of least

resistance (page 35).

Protective and Preventive Inoculations.—Our knowledge of protective inoculations for contagious diseases dates from Jenner's discovery of vaccination against smallpox in 1798. Preventive inoculations with attenuated virus are due to the experiments of Pasteur. This observer discovered the cause of chicken-cholera, and cultivated the micro-organism of this disease outside the body. He found that by keeping his cultures for some time they became attenuated in virulence, and that these attenuated cultures, inoculated in fowls, caused a mild attack of the disease, which attack was protective, and rendered the fowl immune to the most virulent cultures. Cultures can be attenuated by keeping them for some time, by exposing them for a short period

to a temperature just below that necessary to kill the organisms, or by treating them with certain antiseptics. It has further been shown that injection of the blood-serum of an animal rendered immune by inoculation is capable of making a susceptible animal also immune.

A most important fact is that animals may be rendered immune to certain diseases by inoculating them with filtered cultures of the microbes of the disease, the filtrate containing microbic products, but not living microbes. By this method animals can be rendered immune to tetanus and diphtheria. Pasteur's protective inoculations against hydrophobia owe their power to microbic products, and Koch's lymph contains them as its active ingredients. The chief feature in acquired immunity is the presence in the blood and tissues of elements which can neutralize the toxic products of bacteria. These elements are "antitoxins" (page 39). Microbic products are dead and cannot multiply as can living bacteria, hence the human organism is not overwhelmed unless the dose is too large, but the microbic products cause the development of antitoxin as certainly as do the living microbes. The above facts are of immense importance, for on these lines may be solved the problems of the prevention and treatment of microbic maladies.

Orrhotherapy, or serum-therapy, is an attempt to utilize therapeutically the germicidal properties of blood-serum. It is believed that when a person recovers from an infectious disease the alkaline blood-serum is saturated with protective materials, particularly with antitoxin. If this belief is true, it is a proper deduction that blood-serum containing protective material should cure the disease if injected into a patient suffering from an attack. Instead of using the blood-serum itself, some observers have precipitated the supposed curative material from the serum, have dissolved this material, and have administered the solution in fixed amounts. Instead of using the serum of persons rendered immune by an attack of the disease, many physicians have employed the serum of animals rendered artificially immune by injections of attenuated cultures of the bacteria or injections of bacterial products. Some experimenters have even employed the serum of animals naturally immune to the disease. In some cases the serum is given hypodermatically, in some intravenously, in some by lumbar puncture, in some by intracerebral, and in others by intraneural, injection. Claims have been made that serums are efficient when given by the mouth or by the rectum. Paten, of Melbourne, claimed in 1906 that the oral administration of immune serum raises the opsonic index ("Med. Press and Circular," Jan. 31 and Feb. 7, 1906).

Latham ("Lancet," Feb. 15, 1908) and others claim that clinical and bacteriologic evidences are in favor of the view that serums are efficient when given by the mouth. If these views are proved to be true serum-therapy will receive an enormous impetus. Calmette has perfected an antivenomous serum (antivenene) for use after cobra bites. Pasteur has devised a method which will usually prevent hydrophobia (page 306). That Murri, of Bologna, has apparently cured a case of hydrophobia seems proved (page 307). Hosts of observers believe in the utility of diphtheria antitoxin and many are convinced of the value of tetanus antitoxin. The earlier in the disease the injection of antitoxin is practised and the larger the dose the more apt it is to prove curative. When the toxin has not yet combined with cells, antitoxin may keep it from doing so, and when it has recently combined and the combination is still unstable, anti-

toxin may cause disassociation of the combination. When the disease is well established the cell combination of toxin is firm and antitoxin will, in all probability, fail to cure. In order to make diphtheria antitoxin a horse is immunized to diphtheria toxin by inoculating it first with attenuated and then with virulent bacteria. The blood containing antitoxin is withdrawn by bleeding, the serum is separated from the clot, and its antitoxic potency is determined by complicated methods. We signify the degree of potency of a serum by saying that it is of so many "immunizing units," a unit being an arbitrary standard. The average dose for a child is 1000 units and for an adult 2000 units. (Tetanus antitoxin

is considered on page 225; antivenene is considered on page 301.)

Inconclusive experiments have been made in the treatment of syphilis by the serum of dog's blood and by the blood-serum of men laboring under tertiary syphilis; in the treatment of pneumonia with the blood-serum of persons convalescent from pneumonia; and in the treatment of sufferers from septic diseases with antistreptococcic serum-blood-serum of horses rendered immune to virulent streptococci. The real value of antistreptococcic serum is yet uncertain. Occasionally it seems to do great good; at other times it appears to produce no benefit whatever. In several cases of phlegmonous erysipelas and in two cases of malignant endocarditis I thought it was of benefit. Tavel, in an elaborate research ("Klinische-therapeutische Wochenschrift," Vienna, August, 1902), states that he obtained brilliant results in some cases, but no results in others. He does not undertake to explain this variability of action. He thinks the serum benefits staphylococcus as well as streptococcus infections. Antistreptococci serum often fails completely. This is supposed to be due to the fact that there are many different families of streptococci. It was hoped that a polyvalent serum would prove efficient, but the hope is still but a hope. Tavel and Moser prepare serum by using cultures of streptococci obtained from a number of cases of scarlet fever. Van de Velde uses cultures of streptococci obtained from various streptococcic infections. According to Burkard antistreptococcic serum destroys neutrophiles in the blood. This destruction is not harmful if leukocytosis follows the injections, and it does follow them in all cases when the body is able to react to the serum ("Archiv. f. Gynäk.," lxxx., No. 3). Before removing a tongue or an upper jaw it is my custom to give antistreptococcic serum, and I believe that it lessens the tendency to toxemia and to septic bronchopneumonia. Malignant tumors (both sarcomata and carcinomata) have been treated with the blood-serum of dogs, which animals had been injected with fluid expressed from malignant growths (Richet and Hericourt). Von Leyden and Blumenthal obtain a serum by compression of a recent cancerous growth and treat human victims of cancer with it. They claim that the results are encouraging ("Deutsche medicinische Wochenschrift," Sept. 4, 1902). Many claims made for serum-therapy in surgical diseases are exaggerated, sensational, and unscientific. It does not seem possible to obtain an antitoxin for each bacterial malady, and the bacteria of most specific diseases are potent for harm for more reasons than because they form crystalloidal toxic matter. That there is truth in the method seems highly probable, but how much truth there is, is not yet definitely ascertained. It is our duty to study, experiment, and observe, and to reach a conclusion only after honest, careful, and thorough investigation. A little skepticism is as yet a safe rule.

Untoward Effects of Serum Injections.—It has been known for a considerable time that guinea-pigs which had been injected with antitoxin frequently died when injected with the serum again some time later; the curious fact is that the first dose does no harm, but the second dose, given after several days, produces the trouble. In man unpleasant or other dangerous effects may follow the injection of any serum. They occur in certain hypersensitive individuals. They may occur from a first dose, but are far more apt to arise from the second, the third, or some later injection.

The symptoms may be trivial and not arise for several hours. The most common ones are joint pains, weakness, depression, dyspnea, urticaria or erythema, cough, itching, sneezing, edema of the face, and swelling of the

tongue ("Progressive Medicine," Dec. 1, 1908).

The symptoms may be serious and arise in a few minutes. In such a condition any of the previously mentioned symptoms may exist, but the dyspnea is urgent, the face is often cyanosed, and collapse occurs. In some cases death occurs in a few minutes after an injection. When untoward results follow a first injection the condition is regarded as hypersusceptibility to serum. When it follows a later injection it is called serum disease. We fear fatality from an initial dose when there is hypersusceptibility. Serum disease is usually made manifest by minor symptoms developing from eight to thirteen days after a first injection or almost at once after an injection given from fourteen days to four months after the first one. There is no way of knowing beforehand that a person is hypersensitive or that he is liable to serum disease, except that asthma is ominous and makes us fear some untoward effect. In using diphtheria antitoxin or tetanus antitoxin the serum should be given at close intervals and not at intervals of several days.

Treatment of Infections by Bacterial Vaccines.\*—The studies of Wright and Douglas upon opsonins lead to the adoption of this plan of

treating certain infections.

By the injection of an antitoxic serum we seek to directly neutralize toxic products. By the injection of the bacterial vaccines we seek to stimulate the body cells to produce antibodies and particularly opsonin. Bacterial vaccine consists of dead bacteria and their toxins. Each individual has his own response to such an injection, but this response varies at different times. An antitoxic serum contains other antibodies besides antitoxin. Bacterial vaccine is made up with salt solution and is truly specific. A vaccine made up from a certain variety of organisms is valuable only in infections from that variety of organism. In some cases stock cultures are used, but it is better whenever possible to obtain the bacteria from the infected person and obtain our cultures from them (autogenous vaccine). In some cases, however, we cannot wait for the development of a culture and must then use stock vaccines. In a mixed infection it is sometimes uncertain which organism is the main factor in causing the trouble and danger, and yet it is the main factor against which the vaccine must be levelled. Until recently it was believed that the dose must be determined by the opsonic index. This plan is now seldom followed. Each cubic centimeter of Wright's stock vaccine

In this connection see particularly article by Roger J. Lee and article by H. F. Hutwell and Roger J. Lee in "Publications of Mass. General Hosp.," October, 1908. I have used these articles freely.

contains 600,000,000 dead bacteria. The first does is ½ cc. and the second dose is 1 cc. Hartwell and Lee repeat the full dose every fourth or fifth day until the lesions are cleared up ("Publications of Mass. General Hosp.," Oct., 1908). Each injection is made in the subcutaneous tissue, the skin having been previously scrubbed with soap and water and washed with alcohol. In many cases there is a trivial reaction after injection. This reaction is not febrile, is of brief duration, and is manifested by headache, backache, and languor.

There is much testimony as to the value of this plan of treatment. It is particularly serviceable in superficial infections from the staphylococcus aureus (boils and carbuncles). In many cases pain and tenderness begin to abate a few hours after the first injection, a profuse discharge flows from the lesion if it is open, and gathers in the tissues if there is no opening. If the focus of infection is closed it should be incised, but Wright insists that antiseptics must not be used, as they destroy the activity of opsonins. The treatment is of uncertain value in abscess, pyemia, septicemia, and mixed infections.

Tuberculin.-See page 235.

Special Surgical Microbes.—Suppuration (see page 137).—Suppuration is caused by microbes. Does it ever exist without them? The answer is, "Practically no." Injection of a sterile fluid containing dead organisms, or the injection of the sterile products of the growth of pyogenic cocci, will form a limited amount of pus; injection of an irritant forms a thin fluid which may resemble pus, but which is not pus. In surgery pus is very seldom met with without the actual presence of micro-organisms (page 138), and the presence of pus

proves the presence of micro-organisms.

Pyogenic Bacteria. -Pus microbes, or pyogenic microbes, are strongly proteolytic, that is, they possess the property of peptonizing albumin, and thus forming pus. The peptonizing action is brought about by bacterial products. Some believe that pus is not formed by a peptonizing action of the bacteria but that the bacteria furnish a poison (leukolysin) which breaks up the leukocytes, and that the breaking up of leukocytes liberates an enzyme which dissolves albumin. The inflammation which surrounds an area of pyogenic infection is caused by the irritant products of bacterial action (toxalbumins, ammonia, etc.). In the presence of the pyogenic peptones the coagulation of inflammatory exudate is retarded or prevented. Bacteria which ordinarily cause suppuration may not cause it but produce non-suppurative inflammation if they are present in small numbers or if the tissue resistance is at a high level, or if their virulence has been modified by adverse antecedent conditions. Bacteria which ordinarily do not cause suppuration may do so under certain conditions of increased bacterial virulence or lessened tissue resistance. The typhoid bacillus is at times pyogenic, but, as a rule, it is not pyogenic. The usual causes of suppuration are the following microorganisms.

The term *micrococcus pyogenes* (Fig. 15) includes the staphylococcus aureus, the staphylococcus albus, and the staphylococcus citreus. These forms are deviations from one form and are not specifically different. The albus and citreus may be grown from the aureus and they may remain white and yellow or may revert in part to the aureus form ("Atlas of Bacteriology," by Lehmann and Neumann). Some observers maintain that

these forms vary greatly in virulence and hence are specifically different, but the varying virulence has been disputed and it seems to have been proved that virulence may be lessened greatly even when the color does not change. Seventy-seven per cent. of acute abscesses are due to staphylococci (W. Watson Cheyne). Staphylococci are found also in osteomyelitis, in a carbuncle, in a boil, in acne, in pemphigus, in periostitis, in septicemia, and in pyemia, and in some cases of empyema and peritonitis. Some toxic products of staphylococci destroy leukocytes. All of the staphylococci are non-motile.

Staphylococcus pyogenes aureus (Plate 1, Fig. 1, and Fig. 15), the goldenyellow coccus. When grown in the air it produces orange-yellow pigment. This is the most usual cause of abscesses (circumscribed suppurations). The staphylococcus pyogenes aureus grows best in air, but can grow when air is excluded. As it can thus grow it is a facultative, aërobic parasite. It is widely distributed in nature, and is found in the soil, the dust of air, water the alimentary canal, under the nails, on and in the superficial layers of skin, especially in the axillæ and perineum, in the mouth, the nasal cavities, the vagina, and human milk. It forms the characteristic color only when it grows in air (Plate 1, Fig. 1). It is killed in ten minutes by a moist temperature of 58° C. and is instantly killed by boiling water. Carbolic acid (1:40) and corrosive sublimate (1:2000) are quickly fatal to this coccus.



Fig. 15-Micrococcus pyogenes aureus (X 1000). (Lehmann and Neumann.)



Fig. 16.—Streptococcus pyogenes (X 700). (Lehmann and Neumann.)

Staphylococcus pyogenes albus (Plate 1, Fig. 2), the white staphylococcus, acts like the aureus, but is usually more feeble in power. When this organism is found upon and in the skin it is called the staphylococcus epidermidis albus, an organism which Welch proved to be the usual cause of stitch-abscesses.

Staphylococcus pyogenes citreus, the lemon-yellow coccus, is found occasionally in acute circumscribed suppurations, but less often than are the other two forms. Its pyogenic power is even weaker than that of the albus.

The staphylococcus cereus albus and the staphylococcus cereus flavus are found occasionally in acute abscesses, but these forms cannot be sharply differentiated from the micrococcus pyogenes and the names should be abandoned.

Staphylococcus flavescens is occasionally found in abscesses. It is intermediate between the aureus and albus (Senn).

Micrococcus pyogenes tenuis rarely takes the form of a bunch of grapes. It is occasionally found in the pus of acute abscesses.

The micrococcus letragenus is thought to be the bacterium chiefly responsible for the suppuration of tuberculous pulmonary lesions.

Streptococcus pyogenes (Fig. 16).—This coccus, known as the chain coccus, grows best in air and can also grow when air is excluded. It is non-motile and does not bear spores. It is found in the healthy human body in the nasal cavities, urethra, mouth, vagina, and on the skin. It has been found in spreading inflammation and suppuration, erysipelas, pneumonia, otitis, puerperal fever, pyemia, septicemia, lymphangitis, some very acute abscesses, and some cases of meningitis, empyema, peritonitis, ulcerative endocarditis, pericarditis, osteomyelitis, diarrhea, and in certain sore throats. It varies very greatly in virulence and the intensity of its action is strongly influenced by the nature of the soil in which it is implanted. Not only do streptococci produce virulent toxins but they also produce a non-toxic material called hemolysin, which dissolves red corpuscles. Woodhead tells us (Treves' "System of Surgery") that six organisms, each of which bears a separate name, are discussed under this designation. Three of these organisms he places in one group, two in another, and says the sixth may be a separate species.

1st Group.—Streptococcus pyogenes (Fig. 16), found especially in spreading suppuration. Such suppurations spread because streptococci only feebly attract leukocytes and also prevent the coagulation of exudate. Streptococci are also found in very acute abscesses. Cheyne says that 16 per cent. of acute abscesses contain streptococci. The streptococcus pyogenes is easily killed by boiling, and can be destroyed by carbolic acid and corrosive sublimate. These organisms are normally present in the nasal passages, vagina, mouth,

and urethra.

Streptococcus pyogenes malignus, an uncommon organism found in splenic abscess.

Streptococcus septicus has a strong tendency to break up into diplococci.

2d Group.—Streptococcus of erysipelas is found in the capillary lymphspaces in erysipelas. Many bacteriologists believe it to be identical with the streptococcus pyogenes. These bacteria tend particularly to gather in the lymph-spaces. They rarely produce pus and when they do it is usually watery. When ordinary thick pus forms there is a mixed infection with staphylococci.

Streptococcus of Septicemia and Pyemia.—Most observers maintain that it is identical with the streptococcus pyogenes and the streptococcus of ery-

sipelas.

3d Group.—Streptococcus articulorum, found in the false membrane of diphtheria (see the article by Woodhead in the "System of Surgery" by Sir Frederick Treves).

Other Pyogenic Organisms.—The various forms of colon bacillus, the typhoid bacillus, the streptococcus intracellulosis, the micrococcus tetragenus, and the pneumococcus, are at times pyogenic. Pneumococci may produce arthritis (page 647), peritonitis (page 1012), cholecystitis, empyema, necrosis of bone, or wound infection. A case of wound infection due to pneumococci was recently reported by J. H. Beaty ("Northwestern Lancet," July 1, 1907). In many persons pneumococci exist in the mouth. A common form of colon bacillus is the bacillus pyogenes fetidus: it is found in stinking peritoneal pus and in the pus of ischiorectal abscesses. The gonococcus is also pyogenic. Blue pus is produced by the bacillus pyocyaneus (Ernst).

The bacillus pyocyaneus forms chains and may produce suppuration itself. Usually, however, when it appears it constitutes a secondary infection



- Staphylococcus pyogenes aureus,
   Staphylococcus pyogenes albus.
   Bacillus tuberculosis on glycerin-agar, (Warren's Surgical Pathology.)

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in a suppurating area. It causes a blue or blue-green hue in pus and wound discharges.

It is normally found in water and exists in the mouth, intestine, and in the

Other Surgical Microbes.—Streptococcus of erysipelas (Fehleisen's coccus), as stated before, is thought by many to be identical with the streptococcus pyogenes. Their difference in action is believed by Sternberg to be due to difference in virulence induced by external conditions and by the state of the tissues of the host. The coccus of erysipelas is somewhat larger than the ordinary form of streptococcus pyogenes. Infection takes place by a wound, often a very trivial wound of the skin or mucous membrane. The

cocci multiply in the small lymph-channels. This coccus will cause puerperal fever in a woman in childbed when it gains access to "an absorbing surface in the genital tract" (Senn). The streptococcus may cause suppuration in erysipelas, mixed infection not being necessary to induce pus-formation.

The gonococcus, or the micrococcus gonorrhææ (the bacillus of Neisser) (Fig. 18), is the diplococcus which causes gonorrhea. Neisser, in 1879, observed this bacillus in pus from gonorrheal ophthalmia and urethral gonor-



Fig. 17.—Micrococci gonorrhome, highly magnified, schematic. (Lehmann and Neumann.)

rhea. Bumm, in 1887, proved the causative influence of the gonococcus. He reproduced the disease in a healthy female urethra by inoculation with the twentieth generation in descent from a pure cultur. These diplococci are in pairs and each member of a pair is kidney shaped (Fig. 17). Gonococci grow best in air, but can grow when air is excluded (facultative aërobic). Diplococci are found often in the secretions of apparently healthy mucous membranes, and simulate very closely gonoccoci, but genuine gonococci are not so found. The gonococcus is a pure parasite and is not found outside of the organism except

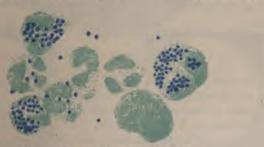


Fig. 18.-Gonococci from gonorrheal pus.

upon articles contaminated with gonorrheal discharge. In male gonorrhea the gonococci are in the urethra and prostate; in female gonorrhea they are in the urethra, glands of Bartholin, and cervix uteri. These cocci may cause gonorrheal conjunctivitis, lymphangitis, lymphadenitis, rhinitis, otitis, proctitis, endometritis, salpingitis, oöphoritis, cystitis, peritonitis, bursitis, thecitis, pleuritis, malignant endocarditis, arthritis, periostitis, abscess, and parotitis. In chronic urethral gonorrhea the gonococci may at times be absent from the discharge, returning when there has been sexual or alcoholic excess, traumatism, or con-

tact with an irritant secretion. In such a case a very few gonococci must have multiplied and the majority of the bacteria must have quickly died, so that there were never many in the urethra at one time, and the discharge must have been kept up by their irritant toxins. If a part in such a condition is irritated, active multiplication begins and the cocci reappear in the discharge. Gonococci cannot be cultivated upon ordinary media, but grow best upon human blood or human blood-serum. In gonorrhea the organisms are found both within and outside of pus-cells and on mucous cells (Fig. 18). The gonococci infect a surface covered with cylindrical epithelium much more readily than a surface covered with pavement-epithelium. They pass into the submucous tissue, cause inflammation, and spread by way of the lymph-paths. It seems certain that the gonococcus is pyogenic, although mixed infection with other pyogenic organisms may exist in this disease. Their presence inside of pus-cells means phagocytosis. Gonococci stain easily by methylene-blue and are readily decolorized by Gram's method.



Fig. 19.-Bacillus of tetanus, with spores.

In noma streptococci are found. No specific organism has been isolated for traumatic spreading gangrene or hospital gangrene.

The bacillus of tetanus or the Bacillus tetani (Nicolaier's bacillus) (Fig. 19) was discovered by Nicolaier in 1884. In 1889 Kitasato obtained a pure culture. It is an anaërobic organism. In recent cultures at least it ceases to grow in the presence of oxygen. It grows within the tissues of the animal body. In a wound to which air has access the bacilli may lie so surrounded by fluid that air is excluded. Pyogenic or saprophytic bacteria may consume the air or the bacilli may lie in a laceration of the tissue the outlet of which is sealed by exudate or blood. It is a facultative saprophyte, that is, under certain conditions it can grow in dead organic material. It is possible to develop by cultivation bacilli which will live in air.

The bacilli of tetanus are widely distributed. They are found in hay, in the soil of gardens, in the dust of old buildings, in street dust and dirt, and in the sweepings of stables. The feces of healthy horses, cattle, and men may contain the bacilli. Tetanus develops after a wound and the bacilli remain in the wound and do not enter the blood. They furnish deadly toxins which are absorbed. The symptoms are due to intoxication, not to infection. The toxin of tetanus is alkaloidal, not albuminoid. These bacilli stain by Gram's method. Cultures are made on sugar-agar plates, the air being excluded. These bacilli when placed under somewhat unfavorable conditions sporulate with great rapidity, and the spores are seen at the ends (Fig. 19). The spores are far more resistant than the adult bacilli, and it is difficult to kill them in a wound. The drug which is most certainly fatal to tetanus bacilli is bromin.

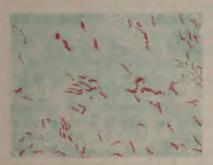


Fig. 20.—Tubercle bacilli in sputum (Ziegler).

The Bacillus tuberculosis (Koch's bacillus) (Fig. 20). This bacillus is the cause of all tuberculous processes. It was discovered and cultivated by Koch in 1882.

It is non-motile and requires oxygen in order to grow, but may obtain this from the body-cells or fluids. It stains by Gram's method and by fuchsin. These bacilli are cultivated upon glycerin-agar or solid blood-serum (Plate 1, Fig. 3). They are found in dust containing the dried sputum of victims of phthisis and dried discharges and secretions of tuberculous patients. This



Fig. 21.—Bacillus anthracis (× 1000). (Lehmann and Neumann.)



Fig. 22.—Bacillus of malignant edema (Lehmann and Neumann).

infected dusty air is the chief means of conveying infection (inhalation tuberculosis). Infection can also be conveyed by inoculation of bacilli (inoculation imperculosis) and by eating the meat and drinking the milk of tuberculous animals (ingestion tuberculosis). Tuberculin is discussed on page 235.

Bacillus anthracis or the bacillus of anthrax (Fig. 21) was first observed by Pollender in 1849 and its causal influence was first demonstrated by Davaine in 1863. It is the cause of malignant pustule or splenic fever. It is non-motile. Tissue containing it is stained by Gram's method. Cover-glass prepa-

rations are stained with a watery solution of an aniline dye. It will grow without oxygen, but grows best in air. In the presence of air sporulation occurs, but it does not occur in the infected animal. It grows upon or in gelatin or agar. Only outside of the diseased body are spores found, and they exist in the hides and hair of infected animals and in stalls and pastures in which diseased animals were kept.

Bacillus mallei or the bacillus of glanders is the cause of glanders. It was discovered by Löffler and Schütz in 1882. It is non-motile and grows best in air, growing with great difficulty when air is excluded. It grows well upon glycerin-agar and does not stain by Gram's method. It is never found except in the body of a diseased man or other animal. It is best cultivated in solid blood-serum. Under certain circumstances some few of the bacilli contain spores.

The Pneumococcus, called also the diplococcus pneumoniæ, Frankel's bacillus, and the streptococcus lanceolatus, was discovered by Steinberg in 1880. It is often found in the saliva of healthy individuals. It is not found outside of the body. It varies greatly in virulence, but when virulent can establish inflammation and even suppuration, particularly of mucous and serous surfaces. It may cause croupous pneumonia, catarrhal pneumonia, pleuritis, meningitis, conjunctivitis, arthritis, peritonitis, periostitis, osteomyelitis, parotitis, salpingitis, empyema, cholecystitis, perinephric and other abscesses, nephritis, tonsillitis, and septicemia. In any of these conditions it may appear in the blood. It

grows best in bouillon cultures and in ascites glycerin-agar.

The Bacillus coli communis, called also the bacterium coli commune, the colon bacillus, or the bacillus of Escherich (Fig. 23), was discovered in feces by Emmerich in 1885. Under ordinary conditions this is a putrefactive bacillus inhabiting the intestinal canal and feces invariably contain it. It is found in the mouth, nose, and vagina, on the skin, and under the nails. The bacillus is normally found in water, even in water regarded by the users as pure. It has already been stated that this ordinarily harmless organism may, under certain conditions, acquire pathogenic power and enter the circulation. This bacterium grows best in air, but it can also grow when air is excluded. It is not stained by Gram's method and has pyogenic power. It stains with anilin dyes and is decolorized by iodin solution. There are numerous forms of colon bacilli, and some of them are motile, some are amotile. This bacillus may be responsible for appendicitis, peritonitis, inflammation of the genito-urinary tract, pneumonia, inflammation of the intestine, leptomeningitis, perineal abscess, cholangitis, cholecystitis, myelitis, puerperal fever, wound infection, and septicemia. It is the cause of many abscesses about the intestine, and is responsible for many ischiorectal abscesses. From the pus of an appendiceal abscess we may perhaps obtain a pure culture of Escherich's bacillus, but usually find also streptococci, staphylococci, or pneumococci,

The Bacillus ædematis maligni, the bacillus of malignant edema, or the vibrione septique of Pasteur (Fig. 22), was discovered by Pasteur in 1875. This bacillus is found especially in stagnant water and certain varieties of soil and exists in putrefying material. It is sometimes motile, but is often amotile and multiplies by spore formation. It is anaërobic and in its growth produces bubbles of gas. In the disease known as malignant edema there is usually a mixed infection with the bacilli of malignant edema and saprophytic organisms, and the latter also form considerable quantities of gas in the tissues. The

bacilli of malignant edema may cause either spreading bloody edema containing gas bubbles or spreading emphysematous gangrene. The bacilli enter the blood and produce septicemia. The bacillus is grown in the interior of a stab in gelatin agar-agar or solid blood-serum when the mouth of the stab has been scaled up.

The Bacillus aerogenes capsulatus of Welch was described by Welch and Nuttal in 1892. This bacillus is found sometimes in abscesses containing gas. It is causative of some cases of gangrenous cellulitis, which is a spreading gangene with gas formation.

It has a capsule and very seldom forms spores. It stains by Gram's method and grows well upon blood-serum.

As pointed out by Lehmann and Neumann, there are occasionally encountered "gaseous phlegmons and similar diseases of internal organs, in which are



Fig. 23.-Bacillus coli communis.

found the bacterium coli alone or usually in combination with other varieties, but without any anaërobes being present" ("Atlas and Principles of Bacteriology," Vol. II., edited by Geo. H. Weaver).

The Bacterium typhi, the typhoid bacillus, or Eberth's bacillus, was distowered by Eberth in 1880. It is sometimes found in water or soil contaminated by typhoid fecal matter. It never exists in the healthy human body. It causes typhoid fever and in this disease can be obtained and cultivated, parficularly from the spleen and lymphatic glands and frequently from the blood. It has been found in the urine, kidney, bone-marrow, and bile. It is difficult in cultivate typhoid bacilli from feces because of the presence of multitudes of other bacteria. The bacillus of typhoid is motile, does not stain by Gram's method, and grows best in air, but can grow when air is excluded. It grows upon Ill the ordinary nutrient media. This bacillus is particularly apt to be confounded with the colon bacillus, and it is even possible that the former develops from the latter. Besides typhoid fever the typhoid bacillus may cause peritoitis, chronic osteomyclitis, gangrene, cholecystitis, thrombosis, embolism, synovitis, and arthritis. This bacillus, under certain conditions, is pyogenic. Typhoid bacilli are agglutinated and lose motion by contact with a 1 to 50 dilution of the blood-serum of a patient with typhoid fever or convalescent from typhoid fever (the Widal reaction).

Putrefactive Bacteria.—By putrefaction we mean the decomposition of albuminous matter with the production of materials possessed of a foul odor. The bacilli of putrefaction act upon dead tissue exposed to air and are most active when the supply of air is somewhat limited. The surgeon encounters these bacteria in areas of necrosis or in tissues previously destroyed by other microbes. In the latter case they cause a mixed infection. An instance of such a mixed infection is putrid pus. Some of the products of putrefactive bacteria are highly poisonous (ptomains). Absorption of a small amount of putrid toxin causes surgical fever and absorption of a large amount causes putrid intoxication.

The chief putrefactive bacteria are: The colon bacillus (when under normal conditions); the bacillus of malignant edema; the proteus vulgaris; the proteus mirabilis; the three forms of the bacillus saprogenes; and the proteus Zenkeri.

We may mention, in conclusion, as of occasional surgical importance the bacillus of influenza, bacillus of diphtheria, bacillus of bubonic plague, bacillus of leprosy, bacillus of rhinoscleroma, bacillus of fetid ozena, bacillus of hemorrhagic septicemia, and the bacillus lactis aërogenes, which is an unusual cause of peritonitis.

The ray-fungus is considered on page 310.

Infections with Protozoa.—Protozoa is the name given to the lowest forms of animal life. This group of organisms shows transitions from forms certainly animal toward forms certainly vegetable. The protozoa are minute unicellular organisms. The cell has a definite nucleus and is composed of protoplasm and a more or less dense cell-wall. Many species have organs of locomotion (cilia or flagella). Pébrine or silkworm disease is due to protozoa, so is trypanosomiasis. Protozoa are known to cause malaria (the plasmodium malariæ) and tropical dysentery (the entameba histolytica). Some observers maintain that they cause cancer, others assert that they are responsible for hydrophobia, it is almost certain that they cause syphilis, and it is thought probable that they may produce measles, smallpox, yellow fever, scarlatina, and spotted fever.

The Spirochæta Pallida.—A bacterial cause of syphilis has long been sought for. Lustgarten thought he had found it in a bacillus resembling the tubercle bacillus, but this view has not been proved. Schaudinn and Hoffmann have described an organism constantly present in the initial lesion of syphilis and in secondary lesions and which they call the spirochæta pallida ("Arbeiten aus dem Kaiserlichen gesundheitsamte," Berlin, April 10, Heft 2). The studies of Schaudinn and Hoffmann were confirmed by Metchnikoff ("Bull. Acad. de med. de Paris," May 16, 1905). These organisms are found in great numbers in the juice of syphilitic glands, in condylomata, and in chancres. They are motile, are without flagella, curve from 3 to 12 times, are stained with difficulty, and are transported by the lymph and blood (Blaschko, in "Berlin klin. Woch.," No. 11, 1907). It is a protozoön and belongs with the animal parasites. The spirochæta was originally discovered by Bordet and Geugm in 1903. These observers found them in chancres, but thought their presence was inconstant. Schaudinn and Hoffmann show that it is constant. Rosenberger says "that it plays some part in the etiology of syphilis seems plausible, as it has not been encountered except by one or two observers in any

other lesion than syphilis" ("Am. Jour. Med. Sciences," Jan., 1906). Very positive claims have been made as to the causal influence of the pale spirochæta and it seems highly probable that it is the cause of the disease. It is present in primary syphilis and all early secondary lesions and in congenital syphilis. It is not found in gummata. As yet it has not been grown in culture. Ewing ("N. Y. State Journal of Medicine," May, 1907) and numerous other observers maintain that it is the real long-sought cause.

## II. ASEPSIS AND ANTISEPSIS.

THE effort in all operations is to secure and maintain scrupulous surgical cleanliness. What is known as the antiseptic method we owe to the splendid labors of Lord Lister, and the aseptic method is but a natural evolution of the antiseptic method. It is true that Agostino Bassi, over half a century ago, convinced that various maladies were due to parasites, treated wounds with a solution of corrosive sublimate. It is also true that Semmelweis in 1847 demonstrated the infectiousness of puerperal fever and the method of preventing it; that Jules Lemaire in 1863 published a treatise on carbolic acid and advocated the use of this drug in the treatment of wounds in order to destroy living germs, and that Bottini in 1866 employed carbolic acid in the treatment of putrid and suppurating wounds because he believed germs to be responsible for such conditions (Monti on "Modern Pathology"). In spite of the above facts, Lister is the real father of asepsis and taught all nations how to prevent infection. Monti says: "But Lister, with that practical spirit which forms one of the best characteristics of English genius, from the scientific studies of Pasteur, deduced the general laws of antisepsis and the rules for their methodical application to practical surgery." Lister called the attention of the profession to a new method of treating wounds, compound fractures, and abscesses in 1867.\* The processes first employed were extremely complicated, but have been made in the last few years simple and easy of performance. Lister believed the chief danger to be from air. It is now believed that the chief danger is from actual contact of hands, instruments, dressings, or foreign bodies with a wound. Air carries but few micro-organisms unless It is filled with dust. Infection through air is most apt to occur if the air is dosty, and is more common after an aseptic than an antiseptic operation.

Of course, some bacteria from the air must settle in every wound, but the majority of the air fungi are harmless. Comparatively few reach the wound unless the air is dusty, and these few the tissues are usually able to destroy. Schimmelbusch made experiments in v. Bergmann's clinic when the students were present. He found that "the number of bacteria which settle upon the surface of a wound a square decimeter in extent, in the course of half an hour, is about 60 or 70," and thousands are usually required to produce infection.

There is no danger of infection being produced by the breath of spectators. Air which comes from the lungs is germ free, and even a large class will not infect the air by breathing, but will rather help to free it from bacteria, for the lungs are filters for air laden with micro-organisms. If a surgeon talks while he is operating he may spray droplets of saliva into the wound and thus produce

<sup>\* &</sup>quot;Lancet," March 16, 1867; "Brit. Med. Jour.," August 9, 1867.

infection. In order to obviate this danger some surgeons wear masks of gauze before the nose and mouth. A conversational assistant is a danger and a surgeon should direct his remarks away from the wound and not toward it. The surgeon and his assistant should wear caps to keep hair from falling in the wound. The clean shaven face is not a peril to the patient, the face "bearded like the pard" may be. A bearded man should wear a mask.

The more simple the operative technic the better and the more certain is it to be carefully carried out. As Desault said, "The simplicity of an operation is the measure of its perfection." The fewer assistants that are used the better and no hands but the surgeons thould enter the wound unless others are ab-

solutely required.

In performing any surgical operation cutting is better than tearing by blunt dissection. The former method makes an incised wound, the latter a lacerated wound. In an incised wound there is a minimum amount of damage and there will be rapid repair. In a lacerated wound some necrosis occurs and there is great lowering of tissue resistance, hence a lacerated wound is much

more apt to become infected than is an incised wound.

Surgical cleanliness may be obtained by either the aseptic or the antiseptic method. In the aseptic method, heat, chemical germicides, or both are used to cleanse the instruments, the field of operation, and the hands of the surgeon and his assistants, the surface being freed from the chemical germicide by washing with boiled water or with saline solution. After the incision has been made no chemical germicide is used, the wound being simply sponged with gauze sterilized by heat; if irrigation is necessary, boiled water or normal salt solution is used, and the wound is dressed with gauze which has been rendered sterile by heat. The effort of the surgeon is simply to prevent the entrance of micro-organisms into the tissues. Some micro-organisms must enter, but the number will be so small that they will be destroyed by healthy tissues. The aseptic method should be used only in non-infected areas. If chemical germicides are not used, there will be a minimum amount of irritation, few cells will be destroyed, the amount of wound-fluid will be small, the surgeon can often dispense with drainage, and repair will be rapid. If a wound is to be closed without drainage, every point of bleeding must be ligated. Many wounds are closed by interrupted through-and-through sutures. Some wounds are closed in layers. If a wound is closed in layers, muscle being against muscle, fascia against fascia, etc., the skin may be closed by interrupted sutures or by Halsted's subcuticular stitch (Fig. 273). If this stitch is employed, the skin staphylococcus does not obtain access to stitch-holes, and stitch-abscesses are not apt to arise. This suture may consist of catgut, silk, or, preferably, silver wire, this latter agent being capable of certain sterilization by heat and exercising a powerful inhibitory action on micro-organisms. If a wound is closed without drainage, firm compression is applied over the wound to obliterate any cavity which may exist. Such a cavity is called a dead space. If a dead space is allowed to remain wound-fluid will gather, tissue resistance will be lowered, and the wound-fluid, the tissue, or both may become infected. Drainage must be used if the wound is very large, if its shape or structure prevents' the obliteration of the cavity by pressure, if there is any doubt as to the perfect cleanliness of the part, if the patient is very fat, for in such individuals fat necrosis predisposes to sepsis and to fat embolism,

and if the skin is so thin that we fear pressure will produce sloughing ("A Manual of Surgical Treatment," by Chevne and Burghard). In some regions of the body wounds are sealed with collodion or iodoform-collodion. If irrigation is not practiced and the wound is dressed with dry sterile gauze, the procedure is said to be by the "dry" aseptic method. In the antiseptic method the same preparations are made for the operation as in the aseptic method, but during the operation sponges impregnated with a chemical germicide are used, and the wound is dressed with gauze containing corresive sublimate or some other chemical germicide. If the wound is not flushed with a chemical germicide, and is dressed with dry antiseptic gauze, the operation is said to be by the "dry" antiseptic method. The antiseptic method is preferred in infected areas. Dry dressings are usually preferable to moist dressings in treating aseptic wounds, because they are more absorbent and do not act as poultices, and dry dressings may be used, even when the wound has been flushed. Some surgeons question the value of antiseptic imgation in a septic wound, but I believe it removes many bacteria and much poisonous matter and also antidotes toxic material. In suppurating areas it is often best to use moist dressings in the form of antiseptic fomentations. Year by year the aseptic method becomes more popular. Surgeons have learned that the most important factor in asepsis is mechanical cleansing by means of soap and water. The chemical germicide plays a secondary rather than a vital part. By mechanical cleansing great numbers of microorganisms are removed along with dirt, grease, and epithelium. Many bacteria remain, but vast hordes are washed away, and the danger of infection is greatly lessened by thus diminishing the number of bacteria. If a chemical germicide is used without preliminary mechanical cleansing, it is useless, because it cannot destroy bacteria in the epithelium and in masses of oily matter. After mechanical cleansing the germicide is active in destroying the comparatively few bacteria which are naked on the surface. In many regions a strong chemical germicide must not be used (in the abdomen, in the brain, in joints, in the pleural sac, and in the bladder), and in other regions (mucous surfaces and fatty tissue) it is productive of harm rather than good.

Preparation for an Operation.—If the operation is to be performed in a hospital there is, of course, an operating room always ready. If it is to be done in a private house, much careful preparation is desirable. The operating room should be warm, but not very warm. The desirable temperature is 78° to 80° F. Over 80° F. is too warm, causes vascular relaxation in the patient, and makes the surgeon perspire and wear out. The patient is kept warm by certain special methods. He may be placed on a table heated by hot water or electricity or he may be surrounded by hot-water bags. Any large w surface is kept covered as far as possible with pads of gauze wrung out of hot salt solution and frequently changed. Protruding intestines are treated in the same way. Every effort is made to avoid soaking the patient's skin with fluids, because as they cool they will chill him. A room in which an operation to be performed should be well lighted and well ventilated. The northern light is the best. It is advantageous to have an open grate in the room, for then a wood fire can be quickly made to take a chill off the air and ventilation is improved. The morning before the operation the furniture should be removed, the carpet taken up, and the curtains and hangings taken down. If the ceiling and walls are papered, they must be thoroughly brushed. If they are painted, they must be washed with soap and water. Dust is thus removed and the danger of dust falling into the wound is averted. The floor is scrubbed with soap and water. The windows should be opened for many hours to thoroughly dry and freshen the room. On the morning of the operation the windows are closed and newspapers are tacked up so as to cover the lower half of each window. Plenty of light is admitted and the curiosity of neighbors across the street cannot be satisfied. The patient's bed is brought into the room and placed in a position where there will be plenty of light for future dressings, and where the surgeon will have access from either side. In order that there may be access from each side the bed must not be in a corner or against the wall. Never use a big broad bed; use a narrow bed. Never have a feather bed, but insist on Treves's advice being followed, and employ a metal bed with a wire netting and hair mattress.

A piece of carpet or rug is spread upon a portion of the floor and the table is set upon it. The table should be so placed that there will be a good light on the field of operation. There are several tables which are very satisfactory. The best for a private house operation is Lilienthal's (Figs. 30 and

31). This table can be folded into a small compass, can be carried in a case with a handle, and is comparatively light and easily transportable. It can be rapidly



Fig. 24. - Plain double wash-stand.



Fig. 25.-Revolving wash-stand.

set up, is firm, and it enables the surgeon to obtain the Trendelenburg position at any moment. A kitchen table does very well. If a kitchen table is used and the abdomen is to be opened a frame should be at hand which, when slipped under the patient, enables the surgeon to obtain the Trendelenburg position. Dr. Joseph Price uses, instead of a table, two trestles and a board like an ironing board. In hospital work I use Boldt's table (Figs. 28 and 29). On the table or board is placed a folded comfortable or several folded blankets and Kelly's pad to catch fluids is laid upon the blankets and is so placed that fluid used in irrigation will flow into it and will be conducted by it to a suitable receptacle.

Around the operating table at proper distances are arranged a table for instruments, a table for dressings, a table for sponges and a basin of bichlorid, and a table for soap and a basin of water. Ordinary wooden tables may be

used if they are covered with towels wet in corrosive sublimate solution. In a hospital special tables are used. They are of iron with glass tops. Ordinary basins may be used, but enameled or glass basins in stands (Figs. 24 and 25) are the most satisfactory. A couple of buckets should be placed on the floor near at hand. Enameled buckets are the best ones to use. The nurses and assistants should have ready the ether cone, wrapped in a clean



Fig. 26.-Porcelain surgical tray.



Fig. 27.-Glass surgical tray.

towel, sterile sheets, sterile gowns, sterile towels, sterile gauze for sponges and dressings, trays for instruments (Figs. 26 and 27), iodoform gauze, catgut, silk, silkworm gut, hot normal salt solution, etc., according to the nature of the operation. The surgeon should pick out the instruments required. The anesthetizer should lay out a mouth-gag, tongue-forceps, a hypodermatic syringe in working order, ether or chloroform, brandy, tablets of strychnin, and also of atropin, and a cylinder of oxygen.

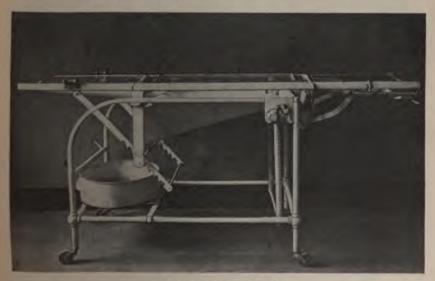


Fig. 28.-Boldt's operating table.

Most surgeons have the operative field sterilized the day before the operation, except in an emergency case. Of late I have been doing it after the patient has been anesthetized and find this plan more comfortable, less troublesome, and equally effective.

When the time for the operation arrives, the surgeon and his assistants remove their clothing and put on duck trousers and thin, short-sleeved shirts of

white muslin. After sterilizing the hands and forearms they envelop their bodies in aseptic or antiseptic sheets or gowns, to protect the patient and themselves, and put on sterile muslin caps. The caps prevent hair, dandruff, and sweat falling into the wound. Mikulicz and some other operators wear over the mouth and nose a respirator or piece of gauze in order to prevent saliva or mucus being projected into the wound while the surgeon talks.

Danger from the Hands.—It is a difficult or impossible matter to absolutely sterilize the hands, but it is fortunate, as Mikulicz and Flügge say, that most of the bacteria of the skin are harmless. The staphylococcus epidermidis albus, however, is constantly present in the epidermis. The hands of some persons are more easily sterilized than those of others. For instance, a hairy, creased hand is more difficult to sterilize than a smooth and almost hair-



Fig. 29.—Boldt's operating table.

less one; a hand grossly neglected, than one reasonably clean. Germs abound in the epidermis, in the fissures and creases, under and around the nails, on hairs, and in ducts of glands. The surface of the hands may be thoroughly sterile at the beginning of an operation and become infected later, because germs in gland ducts are forced to the surface. Hence, in a prolonged operation, the surgeon, if he does not wear gloves, should from time to time stop operating and wash his hands, first in alcohol and then in corrosive sublimate solution (Leonard Freeman).

In view of the difficulty of cleansing the hands, every student must be taught how to do it, and he must become impressed with the fact that the surgical hand is to be regarded as reaching to the elbow. The more hands used in an operation, the greater is the danger of infection of the wound. The surgeon uses retractors and forceps whenever possible, but his fingers

must enter the wound. The fingers of no other person should enter unless absolutely necessary. The basis of all plans of sterilization and the most important part of any plan is mechanical cleansing by scrubbing with soap



Fig. 30.-Lilienthal's portable operating table.



Fig. 31.-Lilienthal's portable operating table, folded.

and water. By this means a quantity of loose epidermis is removed and with it great numbers of bacteria.

Mechanical Cleansing of the Hands and Forearms.-The hands and

forearms may be sterilized in several ways. Any method is preceded by mechanical cleansing, which is carried out as follows: Scrub for five minutes with soap and hot sterile water, giving special attention to the nails and creases in the skin. The water should be as hot as can be borne with comfort, as hot water stimulates the sweat glands and the flow of sweat washes out the ducts. If the ducts are washed out before the operation by copious sweating, during the operation the secretion will be slight. The brush is rubbed in the long axis of the extremity and also transversely. The creases on the back of the hands and fingers will be partially opened by flexing the fingers, and transverse scrubbing will clean the furrows. The furrows on the palmar surface will be opened by extending the fingers, and will be best cleaned by transverse scrubbing (George Ben Johnston). An excellent soap is the ethereal soap of Johnston, which is a solution of castile soap in ether. Green, or castile soap can be used. Many surgeons use synol soap. It is an admirable cleanser but there is no particular advantage in using a soap containing a germicide, as such a soap is practically without germicidal power. The brush employed should be kept in a 1:1000 solution of corrosive sublimate or should have been recently sterilized with steam and kept in a sterile glass box (Fig. 32). The nails are cut short, are cleansed with a



Fig. 32 -Glass brush-box with cover.

knife or, better, with an orange-wood stick, which does not scratch them, and the hands are again scrubbed. Very prolonged or very rough scrubbing, especially with harsh agents like marble dust or sand, is actually harmful as it tends to crack the hands and make them rough and it extensively loosens epidermis which may drop into the wound. Epidermis may contain bacteria within it and may infect the wound.

Sterilization of the Hands and Forearms.—After mechanical cleansing a germicide is employed to render the parts sterile. Whatever method is adopted it is desirable that it shall not unduly irritate the skin. An occasional operator may use without injury tolerably strong chemicals, but the busy hospital surgeon, who operates perhaps several times or many times a day, cannot use them. Any method which inflames, cracks or roughens the skin makes future sterilization difficult or impossible, hence such a method is undesirable. Four methods are described here:

Fürbringer's Method: After washing off the soap in sterile water the hands are dipped in 95 per cent. alcohol and held there for two or three minutes while the forearms, hands, fingers, and nails are being rubbed with alcohol. Alcohol removes the soap which has entered into follicles and creases, removes desquamated epithelium, enters under and about the nails, and favors the diffusion of the corrosive sublimate under the nails and into the follicles, when the hands are placed later in the mercurial solution. Alcohol also hardens epithelium and keeps it from desquamating into the wound. After using the alcohol the hands are then dipped in a hot solution of corrosive sublimate (1:1000), and with the forearms are scrubbed for at least a minute, the nails receiving especial care.

The Welch-Kelly Method: After the hands and forearms have been cleansed mechanically and have been rinsed in sterile water they are immersed for two minutes in a warm solution of permanganate of potassium (a saturated solution in distilled water). This solution causes the cutaneous surface to assume a very dark brown color. The hands and forearms are then immersed in a warm saturated solution of oxalic acid and are held there until decolorized. They are then well washed in sterile water, are next immersed for two minutes in a 1:500 solution of corrosive sublimate, and finally are rinsed in sterile water and dried on a sterile towel. The solutions for use in the above method should be contained in jars of the shape of a druggist's percolator so that both the hands and forearms can be immersed at the same time. In this method the permanganate of potash is merely an oxidizer and the oxalic acid is the active germicide. The skin of some persons tolerates the plan very well, others, among whom is the author, find the oxalic acid decidelly irritant when used several times in a day.

The Weir-Stimson Method: This method was suggested by Mr. Rauschenberg, the pharmacist of the New York Hospital, and it was practically applied by Doctors Weir and Stimson. The process is as follows: The hands should be cleansed mechanically as previously directed or, as Weir prefers, by scrubbing with a brush and green soap and in running hot water and cleaning under the nails with a piece of soft wood. Place about a tablespoonful of chlorinated lime in the palm of the hand, place upon the lime a piece of crystalline carbonate of soda (washing soda) one inch square and half an inch thick, add a little water, and rub the creamy mixture over the arms and hands until the rough granules of sodium carbonate are no longer felt. This requires from three to five minutes. At first there is a sensation of heat usually followed by a sensation of coolness. Place the paste under and around the mils by means of a bit of sterile orange-wood. Wash the arms and hands in hot sterile water.\* Remove the odor of chlorin by washing the hands and arms in sterile ammonia water of a strength of from \frac{1}{2} per cent. to I per cent. McBurney, Collins, and Oastler, in "International Text-Book of Surgery"). The combination of carbonate of sodium and chlorinated lime is said to set free nascent chlorin, a most efficient germicide. This method has proved extremely efficient in the clinic of the Jefferson Medical College Hospital, although when employed several times a day it may prove decidedly irritant. It is important that crystalline washing-soda be employed. If the bicarbonate is used, nascent chlorin will not be produced, but hydrochloric acid gas will be formed, and the latter gas irritates the skin and is not a satisfactory germicide.

The Sublimate-Alcohol Method: This is the method I personally prefer. It is as follows: Cleanse the hands with soap and water as previously directed. Use 95 per cent. alcohol as in Fürbringer's method (page 62). Dip the hands in 70 per cent. alcohol containing 1 part to 1000 of corrosive sublimate, and rub the hands, forearms, and nails with a piece of sterile gauze wet with this fluid for three minutes. Rinse these parts in the fluid and then rinse in sterile water.

The Use of Gloves.—Some surgeons are so impressed with the impostibility of sterilizing the hands that they wear gloves in operations. Hunter \*Medical Record, April 3, 1897. Robb is said to have suggested the use of gloves in 1894, but Halsted began to use rubber gloves in 1889. Mikulicz used white cotton gloves. Lockett has proved that cotton and silk are not impervious to micro-organisms, but that rubber is. The thin, seamless rubber gloves which are now made are very satisfactory. They are sterilized by boiling, are then dried, and are wrapped in a sterile towel. In order to insert the hand in them the hand should be dried, the interior of the glove should be dusted with sterile starch or talc powder, and then the nurse should fold forward the wrist part and hold the glove open while the surgeon inserts his fingers into the proper compartments and pushes the hand in. The custom of filling the glove with sterile fluid and then inserting the hand is troublesome and objectionable, because the fingers soon become sodden like those of a washwoman, the sense of touch is impaired, considerable discomfort is occasioned, and the skin is apt to crack open.



Fig. 33.-Showing rubber glove applied.

If, during an operation, a glove becomes infected, a clean one can be substituted for it. Gloves somewhat impair the sense of touch, but a surgeon soon learns to work with them. If they are to be used, the hands should be sterilized just as carefully as when they are not to be used, because, during the operation, the gloves may tear or be punctured by a needle. I always wear gloves, but that it is absolutely necessary to wear gloves in all cases has not been proved. Their use does contribute to success in brain operations, abdominal operations, and joint operations. They are of great value in military surgery, for the military surgeon may not have time to prepare his hands, and sterile gloves can be always kept ready prepared.

When a surgeon is obliged to place his fingers in an area of virulent infection he may be poisoned. Gloves will save him from this danger. Again, a surgeon should try to avoid bringing his bands unnecessarily in contact with putrid or purulent matter. Though it may not poison him, it grossly infects the surface, renders subsequent cleansing difficult, and endangers other patients. Gloves will prevent this danger. A surgeon should wear

gloves if he is making an examination or performing an operation which is sure to infect the bare hands, and he should wear gloves in an operation if in a previous operation his hands were infected.\* A surgeon whose hands are very hairy or sweat much will contribute to the patient's safety by wearing gloves.

Gloves should be worn if the surgeon has a wound or sore upon his hand or chapped hands. When using gloves in a prolonged operation dip the covered hands now and then in corrosive sublimate solution, because the glove may have been punctured or dust may have settled upon it from the air.

Gloves make the hands sweat and if one should be punctured considerable sweat may emerge from the puncture and enter the wound and sweat often

contains bacteria. The entry of any considerable amount of sweat is more dangerous to the patient than are well cleaned naked hands, hence gloves may actually favor the infection they are meant to prevent. When they are used the surgeon must take scrupulous care not to puncture them with a needle, clip them with forceps, or tear them with a ligature or suture.



Fig. 34.-Half-long rubber glove.

The closer they fit the less the danger of puncture and one should know accurately what size he requires to fit closely and smoothly without being so tight as to make the fingers numb.

Preparation of Gloves.—Wash with soap and water containing a little ammonia, rinse in sterile water, boil for thirty minutes in a 1 per cent. solution of carbonate of soda. Dry the glove and wrap in a dry sterile towel and keep until it is needed. A pair of gloves should stand about 20 boilings. The surgeon should carry a number of pairs of prepared gloves in his bag, for the use of himself and assistants in private house operations.

Instruments are disinfected by subjecting them to the action of steam in a special sterilizer, or better by boiling them for fifteen minutes in a 1 per

cent. solution of carbonate of sodium. They are wrapped into a bundle by means of a towel or piece of gauze and are dropped into the solution. The blades of knives should first be wrapped in cotton to prevent scratching and





Fig. 15.-e., Schimmelbusch's gas-heated apparatus for sterilizing instruments; b, wire basket.

dulling. After boiling, the instruments should be rinsed in hot sterile water

"A review of the literature of disinfection of the hands, by Martin B. Tinker and A. R. Craig, will be found in the Phila. Med. Journal, Feb. 15, 1902. See also Edgar R. McGuire, in "The Best Method of Hand Sterilization," in American Medicine, Feb. 28, 1901; Robert T. Morris, on "Rubber Gloves in Surgery," New York Medical Journal, New 27, 1902; and "Sterilization of the Hands," by Charles Leedham-Green, in the Branigham Med. Review, April, 1904; Nicholas Senn, in Surgery, Gynecology, and Obseries, July, 1905; Reverdin and Massol, in Brit. Med. Jour., Oct. 7, 1905; K. Ved. in Deutsche Medizinische Woch., July 27, 1905; J. R. Williamson, in Brit. Med. Jour., May 14, 1904.

or in a 5 per cent. solution of carbolic acid and be kept until needed in a pan of sterile water. The carbonate of sodium prevents rusting. In a clinic the boiling is carried out in a Schimmelbusch sterilizer (Fig. 35). In a private house it can be done in a sterilizer such as that shown in Fig. 36, or in a pan, a kettle, or a wash-boiler. A sterilizer with a tray is better than an ordinary pan or kettle, because, when the latter is used, the metal instruments lie in the bottom of the vessel, where the heat is very great, and the



Fig. 36.-Portable sterilizer.

temper may be impaired. Boiling unfortunately destroys to some extent the keenness of cutting instruments, the ebullition throwing them about. Hence the knives should be wrapped in cotton to preserve the edges. After sterilization the instruments are placed in

trays containing boiled water. After the completion of the operation the instruments should be scrubbed with soap and water, boiled in soda solution, dried, and placed in a closet with glass shelves so they will not gather dust. Instruments can be partially disinfected by keeping them for thirty minutes in a 5 per cent. solution of carbolic acid or better, in a 2 per cent. solution of formalin. Instruments with handles of wood must not be boiled. If such instruments are used, they can be disinfected by the use of carbolic acid or formalin, but they should not be used. Metal instruments, whenever possible, should consist of one smooth piece. Grooves and letters are objectionable, as dirt gathers in such depressions. Ivory handles cannot be boiled.

Preparation of the Patient.—Whenever possible give the patient some days' rest in bed before a severe operation. This is not possible in an emergency. It is seldom desirable in the case of a highly nervous and excitable woman. Such a patient is sleepless and frightened and loses ground by delay. In most cases this preliminary rest is advisable. It is particularly desirable in a strong active working man suddenly translated from labor to bed. We wish to prepare him to meet operative shock. During the wait the patient is apt to adjust himself to his surroundings, he becomes accustomed to diminished activity and to sick-room routine, forms an acquaintance with his nurses and physicians, and, as a rule, becomes less nervous and more calmly confident of the result. He also learns to use the bed-pan and to micturate while recumbent. A patient while waiting is to have a general bath several times. Some weak and emaciated patients are treated and built up for weeks before the operation is attempted. During this preliminary rest study the disease, and study the individual in order to learn his tendencies, peculiarities, etc. The condition of the lungs, the heart, the blood, and the kidneys should be accurately determined. The amount of urine passed in twenty-four hours should be ascertained, and the percentage of urea should be estimated from a sample of the twenty-four-hour urine. The urine is carefully examined for sugar, albumin, casts, acetone, diacetic acid, etc. By the above examinations we may be able to anticipate and provide against certain calamities. We may be led to postpone or abandon an operation, and we will have the information necessary in order to intelligently select the proper anesthetic. The presence in the urine of acetone and diacetic acid forbids any but an emergency operation. Granular and fatty casts in the urine or a considerable quantity of albumin make us hesitate to operate. A hemoglobin percentage of under 50 makes us seek to avoid operation in most cases not associated with bleeding. The anesthetist should, during this preliminary period, examine the heart and pulse so as to know the natural character of each when the patient is free from excitement. Without this preliminary knowledge he cannot accurately appreciate or intelligently interpret some changes induced by the anesthetic. Constipation must be amended by mild laxatives or enemas, and all fermented matter should be removed from the alimentary canal. Constipation increases the probability of wound infection and greatly impairs the comfort of the patient. As previously shown, the putrefactive bacteria in the intestinal canal, which are usually harmless and are what Adami calls "potential parasites," may escape into the tissues. The retention of fermented matter causes catarrhal inflammation and bacteria escape more easily. If they escape they may lead to damage in the wound and even if wound infection from within does not occur, constipation lessens vital resistance and increases the liability to wound infection from without. Purgatives must not be violent, as anything which greatly depresses a person lessens vital resistance, and powerful purgatives are powerful depressants. The diet should be bland and nutritious, but not bulky. The night before the operation give a saline cathartic, and the morning of the operation employ an enema. Not only do we empty the bowel to lessen the liability to wound infection, but we wish the rectum empty at the time of operation for another reason. It is desirable that the rectum be empty because in shock the absorbing power of the stomach is greatly diminished or is even abolished for the time, and we may wish to utilize the absorbing power of the rectum and give stimulants by enema. When a patient is under the influence of an anesthetic or when he is profoundly shocked, of course no attempt is made to give stimulants by the mouth. Whenever possible give a general warm bath the day before the operation. It is the usual custom the evening before the operation to shave the region if hairy, scrub the entire field of operation, as well as the adjoining regions, with ethereal soap and water; wash with alcohol; scrub with hot corrosive sublimate solution (1: 1000); apply a layer of moist corrosive sublimate gauze, and place over this dry antiseptic gauze, a rubber dam, and a bandage. Many surgeons apply a poultice of green soap for many hours before applying a chemical germicide, in order to separate masses of spithelium and with them many germs. This method is particularly useful in densing the scalp. On removing the dressings to perform the operation, the part is scrubbed with soap and water, and washed with sterile water and then with alcohol. I have become convinced that the teachers in Johns Hoplins Hospital are right and that this preliminary cleansing is not necessary. Neither is it desirable, as it often gives the patient a restless night. It is my custom to have a hairy region shaved before the patient is brought into the operating room. All of the rest of the cleansing is carried out as just described, after anesthetization. In emergency cases disinfection can only be practised just previous to the operation. When the field of operation has been prepared, surround it with dry sterile sheets and towels. Murphy prevents infection from the cutaneous surface by spreading a specially prepared rubber solution over the sterilized operation area. The solution is sterile and sticks to the skin and is applied after the skin has been washed, first with ether and then with alcohol. The rubber is dissolved in acetone and is painted on the skin. The incisions are made through the artificial skin of rubber and the rubber is removed when the surgeon is ready to introduce the sutures. Thus infection of the wound with contaminated secretion of the skin glands is prevented, for, as Murphy says, this elastic covering is "in reality a non-secreting, sterile, artificial derma for the period of operation" ("General Surgery," edited by John B. Murphy, vol. ii., 1905). The patient must be carefully protected from cold by wrapping him in blankets and often by having him wear specially prepared drawers with feet. After the completion of an operation and the application of the dressings the patient is returned to his room or the ward, care being taken to protect him from cold or draughts.

Disinfection of Mucous Membranes.—It is impossible to thoroughly disinfect mucous membranes. We must not scrub forcibly and we must not use powerful antiseptics, because they are irritant and also because they may be absorbed. The best that can be done in the vagina is to rub lightly, when possible, with a bit of moist absorbent cotton and irrigate with a solution of boric acid or with normal salt solution. Another method is to sponge the vagina with creolin and Johnston's ethereal soap (1 and 16) and irrigate with

hot saline fluid or boric acid.

The rectum is prepared by washing out all retained feces by the use of copious high injections and by irrigating with salt solution or boric acid.

The mouth is prepared by having snags of teeth and tartar removed and decayed teeth removed or plugged. For several days before the operation scrub the teeth twice a day with a soft brush and castile soap; and every three hours, when the patient is awake, rinse the mouth with peroxid of hydrogen and spray the nares and nasopharynx with boric acid solution.

The *urethra* is prepared by the administration for several days of salol or urotropin and by frequent irrigation of the urethra and bladder with boric acid solution or normal salt solution or a solution of permanganate of potash

(1:6000).

Preparation of a Patient for an Operation Upon the Stomach.—(See page

1063.)

The Time of Day to Operate.—A hard and fast rule cannot be set as to the time of day when operations should be done. Emergency operations must be performed at once without any consideration as to time. It is often necessary, because of other professional obligations, to set an afternoon hour for an operation. Whenever possible, however, if the nature of the case admits of it, operate in the morning and, preferably, in the early morning. By doing this the patient is saved some hours of dread and worry and the surgeon is enabled to operate when he is fresh, active, and alert; in other words, when he is at his best. A tired mind, like a tired hand, tends to become shaky, and a tired mind may mean incorrect observation, careless technic, impaired judgment, disastrous timidity, or calamitous recklessness.

Irrigation is often practised in septic wounds, but is not required in aseptic wounds. In a septic wound gentle irrigation with a germicide is

advisable. It removes bacteria and toxins and antidotes retained toxins. Irrigation must never be forcible for fear it may disseminate infection. Among irrigating fluids we may mention corrosive sublimate, carbolic acid, peroxid of hydrogen, boric acid solution, and normal salt solution. Hot normal salt solution is the best agent with which to irrigate the peritoneal cavity, the pleural sac, the interior of joints, and the surface of the brain. This solution contains 0.7 per cent. of sodium chlorid.

Many surgeons employ Landerer's dry method in operating aseptically. No fluid is applied to the wound. As the wound is enlarged gauze sponges are packed in to arrest hemorrhage. On the completion of the operation the sponges are removed, bleeding points are ligated, and the wound is often

closed without drainage.

Ligatures and Sutures.—In using sutures always remember that they must be tied firmly, but never tightly. A tight suture will cut when the wound swells and will thus fail of its purpose; further, it produces an area of tissue necrosis, which is a point of least resistance in and about which infection is prone to occur. We would far better use many very fine sutures than a less number of thick ones. The individual suture is weak, but in numbers they give fine support. A fine suture cannot be tied too tight. If we make it too tight the end is frustrated by the breaking of the suture.

Catgut.—The favorite ligature material is catgut. Catgut undergoes absorption in the tissues. Years ago attempts were made by Scarpa, Crampton, and Physick to use absorbable ligatures. Sir Astley Cooper tried catgut. These attempts failed because the material employed was septic, suppuration ensued, the wound gaped, and the ligature was cast off prematurely. Surgeons remained content with non-absorbable ligatures of silk or linen. These ligatures were not cut short, but a long end was left to each one, and the ends were allowed to hang out of the wound. The ligatures were lightly pulled upon from time to time, and when they loosened or cut through were removed. Catgut is the submucous coat of the intestine of the sheep, and is the material from which violin strings are made. It was reintroduced into surgery by Lister. It is obtained in the following manner: The small intestine, after separation from the mesentery, is washed in water, laid upon a board, and scraped with a metal instrument. Thus the mucous coat and the muscular coat are scraped away, and the submucous coat only remains. The submucous coat is cut into strips, and each strip is twisted into a coil. Raw catgut is an infected material. It is difficult to sterilize, because in the twisting many organisms get into the interior of the strand, where it is impossible for unfiscotics to reach them. Raw catgut obtained from animals dead of spicnic fever contains spores of anthrax. If not thoroughly disinfected, catgut is dangerous, and some surgeons consider its cleanliness always a matter of grave question and will not use it. Surgeon's catgut can be bought from the dealer in skeins containing 30 yards. It should be rough and yellow. The smooth white variety should not be purchased. It has been rubbed smooth with a piece of glass and bleached with a chemical, and in consequence is weak and unreliable. The smallest size is known as double zero, then come single zero, No. 1, No. 2, No. 3, and No. 4. The usual ligature size is No.

2. Nos. 3 and 4 are only used for tying thick pedicles. Nos. 1 and 2 are used for suturing the dura and peritoneum and No. 1 for tying small vessels in the brain. McBurney and Collins state that when catgut is used to tie delicate tissue (omental masses, intestinal surfaces, etc.), it must first be softened by immersing for half a minute in normal salt solution. If this precaution is neglected and wiry catgut is used, the ligature or suture will cut and hemorrhage will occur.\* I thoroughly agree with this statement. The greater the diameter of the gut the more uncertain is the sterilization. Nos. 3 and 4 are of doubtful cleanliness, no matter what method of sterilization is employed, and a strand though clean upon the surface may be infected in its interior. When a strand which is infected within is used by the surgeon the tissues are not infected promptly, but after some days when the catgut has been partially absorbed and the spores or bacteria within the strand have been set free. Many late infections are due to catgut infected in the interior of the strand. The smaller sizes I believe can usually be satisfactorily sterilized. I am very uncertain as to the surgical cleanliness of the larger sizes.

If catgut is thoroughly freed from bacteria and the wound in which it is used is aseptic, it is a most satisfactory ligature material, is absorbed in the wound after being cut off short, and produces no trouble, although it does increase wound secretion slightly. The smaller sizes are absorbed in four or five days, No. 2 lasts from nine to ten days, Nos. 3 and 4 from ten days to three weeks. Chromicized catgut is absorbed far less rapidly than

plain gut.

One of the following methods of preparation may be used:

Boiling in Alcohol.—The catgut is soaked in ether for twenty-four hours to remove fat. It is then wound on glass spools, transferred to alcohol, and boiled under pressure. The boiling is conducted in a heavy metal jar with a well-fitting screw-top. The jar is half filled with alcohol. The spools of catgut are placed in the jar, the lid of the jar is screwed down, and the apparatus is immersed in boiling water for half an hour. The gut is kept in this jar until needed. Fowler's catgut is prepared by boiling in alcohol. It is placed in hermetically sealed U-shaped glass tubes. Each tube contains alcohol and 12 ligatures. The alcohol is boiled by immersing the tube in boil-

ing water.

The Cumol Method.—The cumol method is employed by Kelly in the Johns Hopkins Hospital, and is known as Krönig's method. Cumol is a fluid hydrocarbon which boils at 179° C. Catgut is wound upon spools of glass, and these are placed in a beaker glass, the bottom of which is covered with cotton. A bit of cardboard is placed on top of the beaker, and through a small perforation in the cardboard a thermometer is introduced. The beaker is placed in a sand-bath and the bath is heated by means of a Bunsen burner. The temperature is gradually raised to 80° C., and is kept at this point for one hour, in order entirely to remove moisture from the gut. Cumol, at a temperature of 100° C., is poured into the glass, and the heat is increased until the temperature of the cumol is a few degrees below its boiling-point (165° C.). For one hour this temperature is maintained. Then the cumol is poured off and the catgut is allowed to remain for a time in the sand-

<sup>\*</sup> International Text-book of Surgery.

bath at a temperature of 100° C., in order to dry. It is transferred for keeping

into sterile glass jars or test-tubes.\*

The Claudius Method.—The iodin catgut is prepared by the Claudius method. Mr. Moynihan, of Leeds, makes Claudius catgut as follows: In 10 ounces of sterile water dissolve I ounce of crystals of iodid of potassium. When all the crystals are dissolved add 10 ounces of sterile water and then add I ounce of iodin in crystalline form. Dilute the mixture with 4 pints of sterile water. The result is a 1 per cent. solution of iodin and potassium iodid. After the usual preliminary preparation, place the gut in the mixture and keep it in it for at least eight days before using. It can be kept in it without harm for a number of months. Salkindsohn has modified the Claudius method as follows: Use I part of tincture of iodin and 15 parts of proof spirit and immerse the catgut for eight days (J. S. Riddell, in "Brit. Med. Jour.," April 6, 1907).

Silverized Catgut.—Blake advocates this form of gut ("Annals of Surgery," January, 1907). He prepares it as follows: He winds four coils of gut on four glass plates, places the plates in a jar containing a 2 per cent. solution of collargolum and keeps them immersed for a week, the jar being shaken once or twice during the period of immersion. At the end of a week the plates are removed from the silver solution and are placed for from fifteen to thirty minutes in 95 per cent. alcohol, then the gut is wound on glass spools with aseptic

care and is kept until wanted in 95 per cent. alcohol.

The Formalin Method.—The formalin method was advocated by the late Prof. Senn. The catgut is wound on glass test-tubes and is immersed in an aqueous solution of formalin (2-4 per cent.) for twenty-four to forty-eight hours. It is placed in running water for twelve hours to get rid of the formalin. It is boiled in water for fifteen minutes, is cut in pieces and tied in bundles, is placed in a glass-stoppered jar, and is kept ready for use in the following mixture: 950 parts of absolute alcohol, 50 parts of glycerin, and 100 parts of pulverized iodoform. Every few days the mixture should be shaken.

Senn's process is a modification of Hoffmeister's. Even sterile catgut contains a toxic substance which increases wound secretion, has a poisonous effect on body-cells, and favors to some extent limited suppuration. Senn maintains that to counteract this influence gut should not only be sterile, but should be antiseptic, to inhibit the growth of pyogenic organisms which reach the wound from without during operation or subsequently by the blood.

Dry Heat Method.—Boeckman wraps catgut in paraffin paper, seals it in a paper envelope, puts it in the sterilizer, and subjects it to dry heat. For three hours it is heated to a temperature of 284° F., and for four hours to a temperature of 290° F. The envelope can be carried in the pocket or the instrument bag. When the gut is wanted the end of the envelope is torn off, an assistant with sterilized hands unwraps the paraffin paper, and the gut is dipped for a moment in sterile water to make it pliable.†

Corrosive Sublimate Method.—A method which has been largely used is to take raw catgut, keep it in ether for twenty-four hours, soak it for twenty-

<sup>\*</sup>See McBurney and Collins, in "International Text-Book of Surgery," and Clark, in "Johns Hopkins Hospital Bulletin," March, 1896.

<sup>|</sup> James E. Moore, in "Phila. Med. Journal," June 22, 1898.

for hours in an alcoholic solution of corrosive sublimate (1:500), wind it on sterilized glass rods, and place it for keeping in ether or in alcohol.

Johnston's quick method of preparing catgut is as follows: Place it for twenty-four hours in ether; at the end of this period place it in a solution containing 20 grains of corrosive sublimate, 100 grains of tartaric acid, and 6 ounces of alcohol. The small gut is kept in this for ten or fifteeen minutes, the larger gut from twenty to thirty minutes, but never longer. It is placed for keeping in a mixture containing 1 drop of chlorid of palladium to 8 ounces of alcohol. This gut is strong and reliable. At the time of operation the gut is placed in a solution one-third of which is 5 per cent. carbolic acid solution and two-thirds of which is alcohol.

Preparation of Chromicized Catgut.—Chromicized catgut is absorbed less rapidly by the tissues than ordinary catgut. It is used to tie thick pedicles and large arteries, to suture nerves and tendons, and as a suture material in the radical cure of hernia. Chromicized gut, No. 3 and No 4, will remain unabsorbed in the tissues from four to six weeks. The gut should be soaked in ether for twenty-four hours, and be immersed for twenty-four hours in a 4 per cent. solution of chromic acid in water. The gut is then dried in a hot-air sterilizer and is disinfected by one of the several methods. The cumol method is satisfactory.

How to Tie Catgut.—Catgut is tied in a reef knot (square knot) and distinct ends are left on cutting. The second knot, if pulled too tightly, may break the ligature. Moist catgut is slippery and is hard to tie. If a large vessel is tied by catgut, a third knot should be used and the ends cut close

to the knot. Really strong catgut can be tied in a surgeon's knot.

Kangaroo-tendon and Its Preparation.—This material is obtained from the tail of the great kangaroo. It is especially useful for buried sutures in hernia operations; it will be absorbed in the tissues, but only after a long time (sixty to seventy days). Kangaroo-tendon is not grossly infected as is catgut. The material is obtained from a recently killed animal and is promptly dried in the sun. This suture material was introduced by Dr. Henry O. Marcy. It can be prepared in the same manner as the chromicized catgut, and it ought always to be chromicized. Marcy's plan of preparation is as follows: Soak the dried tendon in a solution of corrosive sublimate (1:1000) and separate the individual strands. The individual strands will be of equal diameter and from 10 to 20 inches in length. The diameter depends on the size of the animal. Dry each strand in an antiseptic towel. Chromicize the tendons and keep them until needed in boiled linseed oil containing 5 per cent. of carbolic acid. Before using the strands take them out of the oil. wipe off the oil with a sterile towel, and immerse the tendon for half an hour in a 1: 1000 solution of bichlorid of mercury. This immersion does not make them swell and soften and does not weaken them as it would catgut.

The following method of preparation is recommended by Charles Truax ("Mechanics of Surgery"): Soak the dried tendon until it becomes supple, in a 1:1000 solution of corrosive sublimate. Separate the material into individual tendons, place them lengthwise between two towels; dry them; make them aseptic by soaking in a solution of formalin, as we would do with catgut (see above). After washing out the formalin chromicize the tendon

by placing it in a fresh 5 per cent. solution of carbolic acid containing 1:4000 parts of chromic acid. When the tendons become "dark golden brown" in color, they are removed from the chromic acid solution, dried between sterile towels, and placed for keeping in 10 per cent. carbolized oil. When wanted, they are removed from the oil, and wiped with a sterile towel saturated with bichlorid solution (1:1000). Kangaroo-tendon is tied in a reef knot.

Silk.—This material can be used for both ligatures and sutures; many sizes should be kept on hand. Silk is very strong, soft, extremely supple, and does not swell or irritate the tissue. It can be tied into very firm knots. Ordinary surgical silk is a form of twisted silk—that is, several or many strands are twisted into one. Cable twist or Tait's silk is very strong and is used for tying large pedicles. Braided silk is extremely strong and is made by plaiting together several strands of twisted silk. Floss silk is "a straight fiber slightly twisted" (Truax). Silk is usually tied in a reef knot, but occasionally in a surgeon's knot. White silk may be used, or black silk, which is more easily visible. Silk becomes encapsuled in the tissues. It is not absorbed at all or only after a very long time. It is not a good material for buried sutures, as in the long run it may form a sinus.

Preparation of Silk.—Sutures of silk should be boiled for half an hour before using in a 1 per cent. solution of carbonate of sodium. Some surgeons keep the silk after boiling in sublimated alcohol (1:1000) or carbolic solution (5 per cent.), but it is better to prepare it just before using. A convenient method of preparation is to wind the silk on a glass spool, place the spool in a large test-tube, close the mouth of the tube with jewelers' cotton, introduce the tube into a steam sterilizer, and subject it to a pressure of 10 pounds for twenty minutes, repeating the process the next day. These tubes are carried in wooden boxes sealed with rubber corks.

Horsehair and Its Preparation.—This is used for effecting very neat approximation where only light sutures are required; for instance, in wounds of the face. Its chief use is for capillary drainage. It is prepared by washing and then boiling for fifteen minutes in a 4 per cent. solution of carbonate of sodium. It is kept until needed in sublimated alcohol (1:1000).

Silkworm-gut and Its Preparation.—This material contains fewer bacteria than catgut and does not swell when introduced into a wound. It is strong, solid, smooth, non-irritating, can be drawn through the tissues with slight force, and does not tend to cut the tissue as does a metallic suture. The designation silkworm-gut is a misnomer; the material is not gut at all but s obtained from the silk-producing glands. Italy supplies most of the gut used by fishermen but the gut used by the surgeon comes chiefly from Murcia in Spain. When the silkworms are just ready to spin they are placed in vinegar and water for a number of hours and are thus killed. Each worm is opened and the silk-producing glands are clearly exposed and each gland is drawn by its ends into a single thread. The threads are dried in the air and assume a reddish color (M. J. Triollet, in "Bulletin des Sciences Pharmacologiques," 1905, No. 5. Quoted in "Lancet," Feb. 3, 1906). "This crude silkworm-gut is sold to the manufacturer and further treated. It is first boiled in alkaline water to remove fat and blood and is then dried in the sun, being protected from dust. It is next polished by means of slightly oiled pumice stone. The gut is then bleached with sulphurous acid and rubbed

vigorously with chamois leather to remove dust and sulphur" ("Lancet," Feb. 3, 1906). It is a very valuable material, but is not used for ligatures, as it cannot be tied as firmly as catgut and because when left buried in the tissues the sharp ends may stick and irritate and a point of least resistance may be created. Silkworm-gut is prepared by placing it in ether for forty-eight hours and in a solution of corrosive sublimate (1:1000) for one hour, or it can be boiled in plain water for half an hour. It is carried in a long tube filled with alcohol. A few minutes before using the gut is placed in carbolic acid and alcohol (one-third of the solution is a 3 per cent. solution of acid, two-thirds of it is alcohol). Silkworm-gut is tied by the surgeon's knot.

Celluloid Thread and Its Preparation.—This material is warmly advocated by Pagenstecher. He calls it celluloid yarn, and prepares it from

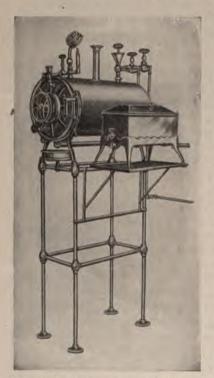


Fig. 37.—Small steam-pressure sterilizer and instrument boiler (Fowler).

English gray linen thread. I have used it with much satisfaction. It is strong. smooth, flexible, and the knot holds firmly; it can be sterilized by any method used for raw silk, and sterilization by dry heat actually increases its strength. Its one disadvantage is that it absorbs about 40 per cent. of fluid, but does not soften. The celluloid is added after the thread has been boiled in a 1 per cent. solution of carbonate of soda, wiped or wrapped in a sterile towel, and dried in hot air or steam. It is then dipped in a solution of celluloid heated in a hot-air sterilizer, and packed in sterile boxes (Schlutius, in "Pacific Med. Journal," Jan., 1900; Keen and Rosenberger, in "Phila. Med. Journal," May 10, 1900). Celluloid thread can be used for sutures or ligatures.

Silver wire is prepared by boiling. It is a very useful suture material, as it can be thoroughly sterilized and has a mild inhibitory effect on the growth of bacteria. Some surgeons use it for buried sutures, but many are opposed to using it thus on the ground that it is apt to lead to sinus formation.

Copper, brass, and bronze have a very distinct inhibitory effect on bacteria (C. L. Green in the "Practitioner," March, 1907), and wire made of either one of these metals is useful. I have used copper wire and brass screws in bone and have used wire of aluminum bronze for various purposes.

Most wounds are closed by interrupted sutures of silkworm-gut, but silk, catgut, chromic catgut, or silver wire can be used. The old continuous suture (glovers' stitch) is rarely used except as a buried suture. An admir-

able closure can be effected by Halsted's subcuticular stitch, and scarcely any scar results (page 56). Marcy's buried tendon sutures are very valuable, especially in hernia operations and in various operations upon the abdomen.

Dressings are made of cheese-cloth. In order to make antiseptic gauze the cheese-cloth is boiled in a solution of carbonate of sodium, rinsed out, and dried; it is then soaked for twenty-four hours in a solution containing r part of corrosive sublimate, 2 parts of table salt, and 500 parts of water. It is placed in clean jars with glass lids, and it may be kept moist or dry.

Sterilized or aseptic gauze is prepared by boiling in carbonate of sodium solution, etc., as described under Antiseptic Gauze. The gauze is then wrapped in a towel and is placed in a steam sterilizer (Figs. 37 and 38) for an hour. It is kept until wanted in sterile glass jars with glass lids. The pads for sponging are made by rolling up portions of sterile gauze. Ashton's abdominal pads are made by taking several layers of sterile gauze, each piece



Fig. 38.-Lautenschläger's steam sterilizer for dressings: A, Exterior view; B, cross-section.

about six inches long and four inches wide, running a stitch around the margin, and sewing a piece of tape into one corner.

Sterile absorbent cotton is prepared in the same manner as gauze. Cotton is useful as a dressing to supplement gauze, being placed on the outside of the gauze. It absorbs quantities of serum, but will take up very little pus.

Iodoform gauze is very useful for packing in the brain and abdomen, for packing abscesses and tuberculous areas, and for dressing foul wounds. It is prepared as follows: Make an emulsion composed of equal parts by weight of iodoform, glycerin, and alcohol, and add corrosive sublimate in the proportion of 1 part to 1000 of the mixture. This mixture stands for three days. Take moist bichlorid gauze, saturate it with the emulsion, let it drip for a time, and keep it in sterilized and covered glass jars (Johnston).

Lister's cyanid gauze (double cyanid of zinc and mercury) is not certainly antiseptic, and must be dipped into a corrosive sublimate solution (1:2000) before using. All forms of gauze can be bought ready prepared from reliable firms.

Some surgeons place silver foil upon a wound before applying the gauze (Halsted, page 32). Small wounds in which drainage is not employed may often be dressed by laying a film of aseptic absorbent cotton over the wound and applying, by means of a clean camel's-hair brush, iodoform collodion (grs. xlviij of iodoform to 5 j of collodion). Among other materials sometimes used for dressing wounds the following should be mentioned: Wood wool, absorbent wool, moose pappe, oakum, jute, peat, and sawdust.

Protectives.—A protective is a material placed directly upon wounds to shield them from irritation and infection and outside of dressings to diffuse and prevent the escape of discharge. The commonly used protectives are Lister's oil silk protective, gutta-percha tissue, rubber dam, waxed paper, paraffin paper, mackintosh, and silver foil. Undoubtedly, many antiseptic agents destroy young cells and in this way hinder repair. The same is true of certain

rough dressings.

R. T. Morris showed us that gauze and particularly cotton are injurious to a healing wound. A non-irritant protective laid directly upon a wound may be useful by saving new cells from injury by an irritant germicide and

from being pulled away at each change of dressings.

Among the best protectives in common use are Lister's protective, guttapercha tissue, and silver foil. Morris condemns guttapercha tissue as irritant. He uses thin gold-beaters' skin made from the peritoneum of the ox, which material he calls Cargile membrane, after an Arkansas physician who introduced it into practice. The advantage of this material is that moisture cannot penetrate and new cells do not adhere. I have used it with satisfaction in some cases but in wounds and ulcers prefer silver foil (see "An Experimental and Histological Study of Cargile Membrane," by A. B. Craig and A. G. Ellis, "Annals of Surg.," June, 1905).

Silver foil, Lister's protective, or gutta-percha tissue is laid directly upon a wound, the dressing being placed above it. Silver foil comes in books and is sterilized by dry heat. Gutta-percha tissue should be sterilized by washing with soap and water, rinsing in sterile water, and soaking in a solution of corrosive sublimate. Lister's protective is employed to save the wound from the irritation of carbolized dressings. In the United States, if it is desired to place an impermeable material *over* a dressing, a rubber dam is usually employed. A rubber dam before being used should be washed with soap and water and soaked in a solution of corrosive sublimate.

The use of an impermeable material on the outside of the gauze dressing is not nearly so common as formerly. In an aseptic wound dry dressing uncovered by rubber is the most useful. When a dressing is covered by an impermeable material it becomes wet, acts as a poultice, and the discharges

on the dressings may undergo decomposition.

Drainage.—Drainage is used in all infected wounds, in most very large wounds, in wounds to which irritant antiseptics have been applied, in cases in which large abnormal cavities exist, in very fat people, and in individuals with such thin skin that we dare not apply firm pressure (see page 57). Drainage is obtained, when needed, by rubber or glass tubes, by strands of horsehair, silkworm-gut or catgut, by pieces of gauze, and occasionally in the abdomen by Mikulicz's bag or tampon by which we obtain pressure to arrest hemorrhage and also secure drainage (Fig. 42). Rubber drainage

tubes (Fig. 39, B) are rendered sterile by boiling in plain water. They are kept until wanted in a mercurial solution. This solution should be changed every

few days, because the mercury is apt to be precipitated as sulphid. Glass tubes are sterilized by boiling. A bit of rubber tissue is sometimes used for drainage. Gauze, catgut, etc., are known as capillary drains. When moist they drain serum excellently, but pus very badly or not at all. Pus



Fig. 39.-Drainage-tubes; A, Glass; B, Rubber.

requires tubular drainage. Drainage-tubes or strands are brought out at a portion of the wound which will be dependent when the patient is recumbent.

Change of Dressing.—When a change of dressings is determined upon the surgeon should carefully sterilize his hands and forearms and should have at hand a warm solution of corrosive sublimate, common salt solution, an irrigator, iodoform, iodoform gauze, scissors, forceps, basins (Figs. 40 and 41),



Fig. 40.-Smith's dressing basin.

etc. Dressings should be moistened before removal with salt solution or corrosive sublimate solution. If they stick to the part a spray of hydrogen dioxid projected from an atomizer between the skin and dressings will soon loosen

them. Dressings must be changed as soon as soaking with blood or woundfluid is apparent. If the wound becomes uneasy and painful or if constitutional symptoms of wound infection arise the dressings must be removed to permit of inspection of the wound. A change of dressings must be effected with all of the aseptic care employed in a surgical operation. Dressings are not dispensed with until the wound is soundly healed.

Removal of Stitches.—Buried stitches of animal material are not temoved by the surgeon but are gradually absorbed in the tissues. Buried stitches of silk or silver wire, which are used by some surgeons, although they are not absorbed in the tissues, may never require removal but in some cases cause



Fig. 41,-Plain dressing basin.

sinuses to form and a sinus from a suture or ligature will not heal until the suture or ligature is removed.

If a catgut stitch is passed through the skin and tied externally the loop in the tissue is absorbed but the knot and remainder of the loop is on the surface and is not absorbed but remains adherent to the wound and the surgeon need only lift it off with forceps. Catgut is used as a material for cuta-

neous suturing in the operation of circumcision. When a skin wound is closed by unabsorbable sutures, as it usually is, the surgeon at the proper time takes forceps and scissors and removes the stitches. Stitches may usually come out from the sixth to the eighth day, although if there is much tension on the edges of the wound they are allowed to remain several days longer. In large wounds, half of the stitches are taken out at one

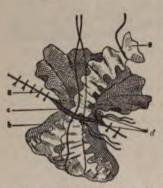


Fig. 42.—Mikulicz's bag; a, Abdominal sutures; b, gauze bag; c, abdominal wound; d, loops in the abdominal wall; e, gauze strip.

time, the remainder being allowed to remain for a couple of days longer. When a stitch begins to cut, it is doing no good, and it should be removed, no matter how short a time it has been in place. If it is allowed to remain, it will cut into the wound, make a stitch-abscess, and cause an irregular suture-line. In order to

remove a stitch pick up an end distal from the knot with forceps, lift it lightly, cut one side of the suture close to the skin by scissors, and remove it by pulling in the direction of the side on which the suture was cut (Fig. 43).



Fig. 43.—Method of extraction of a suture (Esmarch and Kowalzig).

Artificial Sponges.—Bits of gauze should be used, each piece being thrown away as soon as it is soaked with blood or tissue fluid. Gauze pads can be used, soaking them in an antiseptic solution and squeezing them out from time to time during an operation.

Preparation of Marine Sponges.—Marine sponges are seldom used. Gauze pads are preferred. Marine sponges absorb admirably, but they are hard to clean when new and cannot be certainly sterilized in their interiors after becoming infected. They may be prepared as follows: Beat out the dust; place them for forty-eight hours in a solution of hydrochloric acid (15 per cent.); wash them with water; place them for one hour in a solution of permanganate of potassium (3 iij to 5 pints of water); soak for four hours in a solution containing 10 ounces of hyposulphite of sodium, 5 ounces of hydrochloric acid, and 3 pints of water; wash with running water for six hours. Keep the sponges in a jar containing corrosive sublimate solution (1:1000). After using, wash in hot water, soak for half an hour in a solution of sodium carbonate (1:32), wash again in hot water, and replace in corrosive sublimate.

Senn's Decalcified Bone-chips.—Take the shaft of the tibia or femur of a recently killed ox, saw it into portions two inches in length, remove the marrow and periosteum, and place the fragments of bone in a 15 per cent. solution of hydrochloric acid. Change the solution every twenty-four hours. In from two to four weeks the bone will be decalcified. Wash in distilled water, place the pieces of decalcified bone for a few minutes in a dilute solution of potash to neutralize the acid, and then immerse for twenty-four hours in distilled water. The portions of bone are cut into strips in the direction of the long axis of the segments. Each strip is three-quarters of an inch wide

and should be sliced into bits one millimeter thick. These chips are kept in an alcoholic solution of corrosive sublimate (1:500).

Bandages.—For retaining dressings upon wounds the unbleached muslin bandage may be used, but in most cases the gauze bandage is employed. The gauze bandage soaked in corrosive sublimate solution is antiseptic; it does not partly seal the dressing and act like protective; it can be applied firmly, evenly, and rapidly, and is very comfortable.

## III. INFLAMMATION.

Definition.-When the tissues are injured they react or respond, and this reaction or response is known as inflammation. The process of inflammation was defined by the late Sir John Burdon-Sanderson as "the succession of changes which occur in a living tissue when it is injured, provided that the injury is not of such a degree as at once to destroy its structure and vitality." Prolessor Adami, in his article upon inflammation in Allbutt's "System of Medicine," points out that this definition really includes too much. He alludes to the hemorrhage which occurs in the liver after a traumatism, and the subsequent changes in the extravasted corpuscles, and points out that these changes are not inflammatory phenomena. This definition, however, includes all inflammatory conditions, is largely employed, is very useful, indicates the cause, and, as Burdon-Sanderson says, makes clear that inflammation is a process and not a state (Adami). Adami's definition is as follows: "The series of changes constituting the local manifestation of the attempt at repair of actual or referred injury to a part, or, briefly, the local attempt at repair of actual or referred injury." The changes alluded to in Burdon-Sanderson's definition comprise (1) changes in the vessels and the circulation, (2) departure of fluids and solids from the vessels, and (3) changes in the perivascular

Vascular and circulatory changes were formerly thought to be absolutely essential to inflammation in both vascular and non-vascular tissues. In the former they occur in the inflamed tissues; in the latter (cornea and cartilage) they are manifest in neighboring tissues from which the non-vascular area derives its nutritive material. As a matter of fact, in inflammation, vascular changes are almost always present; but in a rather trivial corneal inflammation the episcleral vessels may not dilate, and the only white corpuscles which gather in the damaged area are those which come from the lymphspaces of the cornea. Inflammation in any tissue will not be accompanied by vascular dilatation unless the process reaches a certain stage of severity.

Active Hyperemia.—When an irritant is applied to tissue there may be a momentary arterial contraction due to irritation of the nerves, but this contraction is transitory, and is not an inflammatory phenomenon. The first vascular phenomenon is dilatation of all the vessels,—capillaries, venules, and arterioles,—appearing first and being most pronounced in the small arteries. As a result of the dilatation there are increased rapidity of circulation and increased determination of blood to the part, and the area of hyperemia becomes warmer than is normal. This condition of increased circulatory artivity is known as "active hyperemia" (Fig. 45).

Active hyperemia is an increase in the amount of moving blood in a part. Passive hyperemia is an increase in the amount of blood in a part, but not of moving blood, as passive hyperemia or congestion is due to venous obstruction, and the blood is stagnated. Diminution in the amount of blood in a part is ischemia. Local anemia is the complete cutting-off of the blood-supply of a part.

In active hyperemia more blood goes to the part and more blood passes through it, an increased amount of venous blood comes from the hyperemic area, the venous tension is increased, and the veins may even pulsate. The capillaries, which under ordinary circumstances contain but few blood-cells (Fig. 44), become filled with corpuscles (Fig. 45), and even the smallest capillaries pulsate. The blood in the veins adjacent to the area of inflammation is of a much lighter red than in health. Many capillaries which were invisible



Fig. 44.-Normal vessels and blood-stream.

under normal conditions become visible when active hyperemia exists. The capillaries contain no muscle-fiber, and hence these tubes cannot actively contract, except so far as the caliber of the tubes is altered by the contraction or expansion of the endothelial cells of the capillary wall. Contraction and dilatation of the capillaries depend chiefly on the amount of blood sent to or retained in them. In active hyperemia the increased amount of blood sent to the part causes capillary dilatation. As a result of the dilatation the endothelial cells become thinner than before, the cells as a result of irritation lose some of their power to restrain exudation, and some observers assert that openings are formed between the cells or that previously existing openings enlarge (page 83). Fluid elements rarely leave the bloodvessels during active hyperemia, but they

occasionally do. The wheals of urticaria are thus formed (Warren). Active hyperemia is often the first stage of an inflammation, but it is not of necessity followed by other inflammatory changes, and it can be caused by nerve section or nerve stimulation.

The duration of active hyperemia is variable. If the irritation was brief, the hyperemia is very transitory. In some cases dilatation with accelerated circulation is scarcely more than momentary, giving way almost immediately to dilatation with retardation. If the irritation is prolonged, hyperemia may last some time before giving way to retardation. In the web of a frog's foot, if an irritant is applied, hyperemia lasts from one-half hour to two hours before it is replaced by retardation.

Clinical Signs of Active Hyperemia.—A hyperemic part, if on or near the surface, is red in color, imparts a sense of heat to the examining hand, the color quickly disappears on pressure and quickly returns when pressure is released. In a congested part the temperature is diminished, the surface is purple, the congested veins are visible, there are edema and a sensation of coldness and numbness. When congestion is purely local, the lividity disappears quickly when pressure is applied and returns quickly when pressure is removed. When due to disease of the heart or lungs, it disappears and returns slowly. When a local congestion is about to give way to gangrene, the lividity disappears very slowly on pressure and crawls back slowly when pressure is released.

Retardation.—After active hyperemia has existed for a variable time the blood-current begins to lessen in velocity, until it becomes more tardy than in health. This is known as "retardation of the circulation." Retardation is first noted in the venules, next in the capillaries, and last in the arterioles; but arterial pulsation continues. The red cells take the center of the bloodstream, which is known as the axial current. The white corpuscles settle out of the central stream, separate from the red, and float lazily along near the vessel-wall, and they are accompanied by many third corpuscles. The white cells show a strong tendency to adhere to the venule-walls, and, as a result, accumulate against the inside of, and stick to, these walls and to one another, until the venules are entirely lined with layers of leukocytes (Fig. 46).

third corpuscles act in a similar manper and take the peripheral current. In the capillaries some leukocytes gather, but not many. In the arterioles they adhere during cardiac dilatation, but are swept away by the force of the heart's contractions. Retardation is believed to be chiefly due to paresis of the muscular walls of the arterioles. This causation seems probable when we recall Lord Lister's experiments won the pigment-cells of the frog's kot. Lister proved that inflammation paralyzes the pigment-cells, and concloded that dilatation at the focus of an inflammation is due to the paralyzing action of an irritant. Dilatation at a distance from the focus is a reflex phenomenon (W. Watson Cheyne). When the vessels are weakened or Fig. 45.-Dilatation of the vessels in inflammation. paralyzed, the contractions of the arte-



ticks are feeble or absent, and the blood is no longer urged forward by arterial power. The endothelial cells of the small vessels enlarge distinctly during tetardation and develop a condition of stickiness, which leads the white cells to adhere to them, and thus increases resistance to the current of blood and adds to retardation. Fluids pass through the wall of a vessel in this condition more readily than through a healthy vessel, and white corpuscles have the vessel in large numbers.

Oscillation and Stagnation.-By this accumulation of leukocytes the blood-stream is progressively narrowed and the axial current is impeded, The red blood-cells begin to stick to one another, forming aggregations like

rouleaux of coin, which masses increase the difficulty the axial current has to contend with, until progressive movement ceases and the contents of the vessels sway to and fro with each heart-beat. This is the stage of oscillation. In a short time oscillation ceases and the vessels are filled with blood which does not move, and the vessel-walls become irregular in outline or even pouched. This stage is known as "stasis" or "stagnation." Stasis is chiefly due to paralysis and damage of the vessel-walls. Migration ceases when stasis takes place. If stasis persists, coagulation occurs, because the vessel-walls have been so injured by the irritant as to be practically dead material, and they are no longer able to prevent clotting of their contents. Finally, in persisting stasis the vessel-walls rupture or are entirely destroyed.

Résumé of the Vascular Changes of Inflammation.—We can sum up the vascular changes of inflammation by stating that they consist in a dilatation of the small vessels and a primary acceleration, a secondary retardation, and a subsequent stagnation of the blood-current, exudation of blood-liquor, adhesion of leukocytes to the walls of veins and capillaries, migration of leukocytes, the aggregation of the red blood-cells into intravascular masses, and coagulation

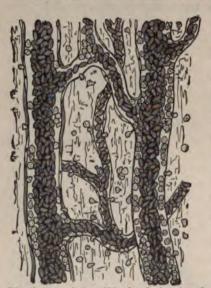


Fig. 46.—Retardation of blood and migration of white corpuscles in inflammation.

of the material remaining in the vessel. Exudation of Fluids.—It is to be remembered that in the process of nutrition blood-liquor and also white cells pass into the tissues through the walls of veins and capillaries, and during this process certain other materials are passing from the tissues into the vessels. Hence, a diffusible irritant in the vessels may pass into the tissues and a diffusible irritant in the tissues may pass into the vessels. Whenever retardation of the circulation arises, there is an increase in the amount of plasma which passes out of the vessels, but in inflammation the exudation into the lymph-spaces is vastly greater in amount and is different in composition. In a slight inflammation, and in the early stage of any in-

flammation, there is an increase in the

fluid exudate, and we speak of the condition as "serous inflammation." This fluid is really not serum, but is liquor sanguinis. We find true serum in passive congestion, not in active inflammation. The fluid in a serous exudation contains very few white cells, and hence little or no fibrin can form in it, and coagulation does not take place in the perivascular tissues; and if the inflammation goes no further, the exudate is absorbed by the lymphatics. A blister is an example of serous inflammation. If the inflammation continues to intensify, the exudation is altered in character—it becomes thicker, turbid, and very coagulable and exhibits a greatly increased bactericidal power. It contains many white cells and fibrin elements, and coagulates in the tissues, because some of the leukocytes

break up and set free fibrin ferment, and fibrin ferment causes the union of calcium and fibrinogen and the formation of fibrin. This fluid exudate is known as "lymph," or plastic exudation, and when it is present we speak of the condition as "plastic inflammation." Lymph can be seen in the anterior chamber of the eve in cases of plastic iritis. Coagulated fibrin in a recent wound causes the edges to adhere or glazes the raw surface. In inflammation of a mucous surface it may appear as a false membrane. In inflammation of serous surfaces it may glue the surfaces together and lessen motion, the fibrinous masses which effect the gluing being called fibrinous or plastic adhesions. These adhesions within the abdomen may seal a perforation, may cover a raw spot, or may encompass an area of infection and prevent fatal diffusion. Further fibrin surrounds and entangles bacteria and retards their diffusion. Pyogenic cocci lessen, retard, or prevent fibrin formation or destroy fibrin previously formed. The fibrinous adhesions may, of course, do harm. They may retard or prevent the absorption of exudate; they may narrow and obstruct important structures (bowel, urethra, larynx), they may bind up and cripple an important viscus (liver, heart or brain). Fibrinous adhesions may be succeeded by dense contracting and constricting bands of fibrous tissue. The lymphatics endeavor to absorb the fluid exudate in inflammation, but become occluded by coagulation, and the area they drain becomes swollen, hard, and "brawny." The slighter the inflammation, the less albuminous is the fluid; the more intense the inflammation, the more albuminous is the fluid. The focus of an inflammation usually feels brawny because of coagulation of a highly albuminous exudate; the periphery of an inflammation is soft and edematous because of the presence there of thin and non-coagulable exudate. Inflammatory lymph contains proteids and other substances. "Of these the more important are ferments, the results of proteolysis (notably fibrin and its precursors and peptones), and in many cases mucin, together with bactericidal substances, and, where bacteria are present, the products of their growth."\* The amount of the exudation varies with the violence of the irritation, the nature of the irritant, the general condition of the organism, and the state of the tissues which are involved. In dense tissue (bone, periosteum, etc.) the exudation is scanty. In loose tissues (subcutaneous tissue) it is profuse. Profuse exudation may take place into a joint, the pleural sac, the peritoneal cavity, or the pericardium. In such cases the exudation is profuse because the serous membrane has a thin covering of endothelium, contains quantities of vessels, and the vessels receive but a thin covering and obtain but a scant support towards the cavity.

Does the plasma leave the vessels as a simple filtrate? Some maintain that it does. Heidenhain and others claim that it does not, and believe that the endothelial cells play an active part in the process. Heidenhain likens endation to secretion, because some materials from the plasma pass out and others do not. Adami is inclined to agree with Heidenhain, that the crithelium plays "not a passive, but an active rôle." Are there spaces between the endothelial cells of the capillary? It was long taught positively that there are no open spaces between the endothelial cells of the vessel-wall, and that these cells are held close together by a cement substance. It is now believed by some observers that spaces exist between the protoplasmic strands which

<sup>\*</sup> Adami, in Allbutt's "System of Medicine."

hold the cells together, these spaces being closed when the vessel is contracted and open when the vessel is dilated. When these spaces are open fluid passes, and through these doorways leukocytes emerge.

Migration and Diapedesis.—Even early in an inflammation some few white corpuscles pass through the vessel-walls; but when the inflammation is well established, large numbers, and when it is severe vast hordes, pass into the perivascular tissues. This process is known as "migration" (Figs. 46 and

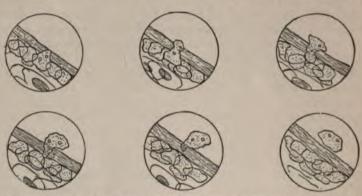


Fig. 47.-Stages of the migration of a single white blood-corpuscle through the wall of a vein (Caton).

47). The leukocytes throw out protoplasmic arms, insert themselves between the cells of the walls of the vessel, and pull themselves through by their power of ameboid movement (Fig. 48). Some observers claim that they do not pass through existing open doors, but form openings which close after them. This is readily accomplished, because the vessel-wall is itself damaged, weakened, and convoluted. Others claim that stomata exist between the endothelial

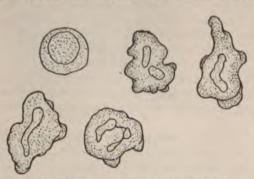


Fig. 48.-Ameboid movements of a leukocyte (Warner).

cells, the vessel-wall being porous like a filter (page 83). The escape of leukocytes takes place chiefly from the venules, though some migrate through the capillaries and even the arterioles (Fig. 46).

The leukocytes are influenced to move toward the damaged tissue by the attractive force known as positive "chemiotaxis," a force which draws them toward

invading bacteria, to regions of irritation, and to areas of tissue death. Leukocytes may move from very virulent organisms, influenced by what is known as negative "chemiotaxis." The migration of a leukocyte requires but a short time. Fig. 47 shows the migration of a white blood-cell through a vein-wall, the process requiring one hour and fifty minutes. In very acute inflammations red corpuscles also pass into the tissues. Red corpuscles are not

capable of ameboid movements, and if they do escape from the vessels the process is passive on their part and not active. This passive escape happens because the capillary walls have been destroyed or because stomata have been greatly enlarged by vascular dilatation. If red corpuscles do pass into the exudate, as happens in pneumonia, the inflammation is a very severe one and is called a hemorrhagic inflammation. The escape of corpuscles by a passive process is known as "diapedesis," in contra-distinction to the escape of leukocytes by active ameboid movements, a process known as "migration." The white corpuscles usually greatly increase in number in the blood of a person who has an acute inflammation, and the blood-making organs, such as the spleen and lymphatic glands, are often enlarged. An increase of white corpuscles in the blood of an individual is called leukocytosis.

Blood Plaques.—Blood plates, blood plaques, or third corpuscles, may be discovered in freshly drawn blood, but, unless they are present in unusual numbers, they will rarely be seen in specimens prepared in the usual way. The third corpuscles can be seen by a high power microscope in the moving blood of the web of a frog's foot. In blood outside of the body they are destroyed as soon as coagulation begins, and in order to see them coagulation must be prevented. Some observers maintain that the third corpuscles are the real fibrin-formers. The blood plaques, or third corpuscles, are found to be present in increased numbers in inflammation. In health their usual proportion to red cells is as 1 to 20. They are especially numerous at the height of fever

processes and during convalescence from an extensive abscess.

Changes in the Perivascular Tissues.—The cells of the perivascular tissue are phagocytes and when stimulated they enlarge, become more actively phagocytic, and undergo reproduction. The liquor sanguinis which exudes during an acute inflammation coagulates unless prevented by virulent bacteria. It has often been asserted that exudation is Nature's method of supplying nutriment to the cells of the damaged region. Adami points out the apparently contradictory observation that the amount of exudate is in direct proportion to the rapidity of cell-destruction, but nevertheless concludes that exudation stands in close relation with cell-proliferation.\*

From whatever cause, tissue-cells multiply, and this process is known as "cell-proliferation."

When a tissue is injured it inflames, and, as Adami points out, the reaction

we call inflammation is an attempt to repair injury.

Irritation may lead to degeneration and death of cells; it may lead to growth and multiplication. In many cases both processes are active in the acute stage, the cells at the focus of the inflammation undergoing degeneration and destruction, and those at the boundary undergoing growth and proliferation.†

If tissue-cells have been seriously damaged, they perish, and new cells are required to replace them. The inflammatory process has led to exudation of plasma and migration of leukocytes into the perivascular tissues. The connective-tissue cells multiply and produce young cells, which are known as "pibroblasts," and which eat up many leukocytes. Early in an inflammation polynuclear leukocytes preponderate, later mononuclear phagocytic cells

<sup>\*</sup> Adami, in Allbutt's "System of Medicine."

predominate (Opie). The leukocytes contain two enzymes. One is derived from bone marrow and digests proteid in an alkaline medium; the other is derived from lymph-glands and digests proteid in an acid medium (Opie). The migrated leukocytes in part surround the inflamed region and retard diffusion of the process. Many enter the diseased area and attack bacteria. Some undergo degenerative changes and liberate fibrin ferment which makes the exudate clot. Some move out of the inflamed area, each one carrying within it tissue débris, and many are eaten up by the fibroblasts. There is no real proof that leukocytes proliferate and help directly to form new tissue. This mass of young cells, taking origin from the fixed cells, has been called embryonic tissue, because of a fancied resemblance to the cells of the embryo. John Hunter called it juvenile tissue. It has also been called indifferent tissue, because of the belief that it could be converted indifferently into various tissue according to circumstances. It is also spoken of as inflammatory new jormation.

An exudation may be absorbed by the lymphatics. It may be converted into pus if infected with pyogenic bacteria, or be replaced by cells from the proliferation of fixed tissue-cells, the cellular mass being subsequently vascularized by the extension into it of capillary loops derived from adjacent capillaries. When embryonic tissue is filled with blood-vessels,—that is to say, when it is vascularized,-it is called granulation tissue. Granulation tissue is finally converted into fibrous tissue. The above complicated processes. vascular and perivascular, are not accidents nor haphazard freaks, but are Nature's efforts to bring about a cure.

Dilatation is due to the direct effect of the irritant upon the muscle or its nerve-elements. Retardation and stasis are due to paralysis of the vesselwall, which paralysis causes resistance to the passage of the blood-stream and adhesion of the leukocytes to the vessel-wall. The blood-liquor exudes and the leukocytes migrate. Often these efforts of Nature succeed. Acceleration of the circulation may succeed in washing away an irritant from the vessel-wall. By bringing quantities of blood to the part it secures copious exudation of plasma. The exudation may wash and remove irritants from the tissues, and the germicidal blood-liquor may destroy bacteria in the damaged area. The migration of corpuscles may prove of great service. The leukocytes surround an area of infection and tend to limit its spread. Leukocytes have phagocytic properties, and energetically attack and often destroy bacteria, and they furnish enzymes which may digest proteids and antitoxins which antagonize and may neutralize the poisons produced by micro-organisms. Leukocytes aid in forming fibrin. Fibrin formation is of service by helping immobilization and by hindering the spread of bacteria. Leukocytes also aid in separating dead tissue from living, and they remove tissue débris from the area of inflammation. The multiplication of the fixed connective-tissue cells leads to the formation of fibroblasts, and fibroblasts are converted into fibrous tissue, which effects permanent repair (these changes will be alluded to again in the section on Repair).

Nature may fail in her efforts. For instance, an enormous exudate in-

creases stasis and may cause such tension that gangrene results.

Inflammation in Non-vascular Tissue.—A type of non-vascular tissue is the cornea, and the cornea can inflame. The healthy cornea contains

no blood-vessels. It is formed of many layers of fibers, each layer running parallel with the corneal surface and forming angles with the fibers of the adjacent layers. Between the layers are communicating lymph-spaces containing connective-tissue cells known as corneal corpuscles. It obtains its nourishment in part from the vessels of the conjunctiva, but chiefly from the vessels of the ciliary body and sclera. When the cornea inflames, the episcleral, conjunctival, and ciliary vessels usually dilate and pour out exudate, and the fluid exudate and the leukocytes enter into the corneal lymph-spaces. The exudate coagulates and cell-multiplication ensues as in any other inflammation. In mild inflammations the vessels about the cornea may not dilate. Leukocytes, from the lymph-spaces, reach the seat of injury in small numbers, and the fixed cells multiply. Nancrede points out that in trivial inflammation which injures but does not destroy the epithelium leukocytes may not go to the seat of inflammation, the only change being enlargement and multiplication of corneal corpuscles. If new formation takes place, a permanent opacity mars the cornea as a consequence.

Cartilage has no blood-vessels except in regions where growth is very active or where ossification is taking place. Cartilage has no spaces, like the cornea, for a free circulation of lymph. In man canals have not been demonstrated and it is thought that fibrils conduct nutritive fluids, the nutritive plasma flowing between the cells, but there is no direct connection with blood-vessels. The plasma is furnished by the vessels at the margin of the perichondrium. Cartilage can inflame and an inflammation of this structure is slow in evolution and of long duration. When inflammation occurs, the cartilage cells enlarge and their nuclei proliferate, the intercellular substance softens and cartilage cells may be cast off. After a long time vessels may invade the inflamed cartilage and fibrous tissues form from the perichondrium, but in some cases a loss of substance is not repaired.

Inflammation of Mucous Membrane.—It may be catarrhal, suppurative, croupous, or diphtheritic. In a catarrhal inflammation the increased blood-supply causes an excessive flow of mucus. The submucous tissues present the ordinary changes of inflammation and quantities of epithelial cells are cast off from the surface. Fibrous tissues may form in the submucous tissue and thus cause permanent thickening (strictures, etc.).

Suppurative inflammation is usually preceded by catarrhal inflammation. In this condition the discharge is mucopurulent and ulcers are apt to form. A trivial loss of substance permits of regeneration, but a considerable loss is repaired by fibrous tissue which by its bulk and by contracting may interfere greatly with the functional usefulness of an organ or a canal.

A croupous inflammation is one in which quantities of epithelial cells are cost off the surface and there forms upon the surface a highly fibrinous expedite (false membrane).

In diphtheritic inflammation the mucous membrane is destroyed and the false membrane invades the submucous tissue. Diphtheritic inflammation is due to a specific bacillus.

Classification of Inflammations.—The various forms of inflammations are—(1) Simple or common, that which is due to any ordinary traumatic, chemical, thermal, or actinic cause, and not to bacteria, such as traumatic periostitis or sun dermatitis. It does not tend particularly to spread. As a rule, the cause of a simple inflammation is momentary in action; (2) infective or specific, that which is due to micro-organisms, as the streptococcus of erysipelas. An unsuccessful attempt has been made to charge all inflammations to bacteria. It is true that bacteria can generally be found in inflammatory areas, but that they are the only causes of inflammation is accepted by few. Infective inflammations often tend to spread widely: (3) traumatic. which is due to a blow or an injury; (4) idiopathic, which is without an ascertainable cause. There is certainly a cause, even if it cannot be pointed out. and the term "idiopathic" means that we do not know the cause: (5) acute. which is rapid in course and violent in action; (6) chronic, which follows a prolonged course; (7) subacute, which is intermediate in violence and duration between acute and chronic; (8) sthenic, characterized by high action. Occurs in strong young subjects; (9) asthenic or adynamic, occurring in the old, the debilitated, and the broken-down. In such an inflammation there is no certain limitation of the inflammation by leukocytes, and there is an indisposition on the part of the tissue-cells to form fibroblasts; (10) parenchymatous, affecting the "parenchyma," or active cells of an organ; (11) interstitial, affecting the connective-tissue stroma of an organ; (12) serous. characterized by profuse non-coagulating exudation (as in pleuritis) or by marked inflammatory edema; (13) plastic, adhesive, or fibrinous, characterized by an exudation which glues together adjacent surfaces, as in peritonitis: (14) purulent, phlegmonous, or suppurative, when pyogenic cocci are present and multiply; (15) hemorrhagic, when the exudate contains many red bloodcells, as in strangulated hernia and in the pustules of black smallpox; (16) croupous, when an inflammation produces upon the surface of a tissue a fibrinous exudate which cannot be organized into tissue, and which is due to the action of micro-organisms. An exudate of this character was called by the older surgeons "aplastic lymph." It occurs most usually on mucous membrane; (17) diphtheritic, which differs from croupous in the fact that the false membrane is in the tissue rather than upon it; (18) gangrenous, an inflammation resulting in death of the part, the gangrene being due to the tension of the exudate or the virulence of the poison; (19) healthy, when the tendency is to repair; (20) unhealthy, when the tendency is to destruction; (21) latent, an inflammation which for some time does not announce itself by any obvious symptoms, as the inflammation of Peyer's patches in typhoid fever; (22) contagious, when its own secretions can propagate it; (23) dry, without exudation; (24) hypostatic, arising in a region of passive congestion (as a bed-sore); (25) malignant, due to a malignant growth; (26) catarrhal. affecting a mucous membrane; (27) neuropathic, due to impairment of the trophic functions of the nervous system, as in perforating ulcer; and (28) sympathetic or reflex, due to disease or injury of a distant part, as when orchitis follows mumps.

Extension of Inflammation.—Inflammation extends by continuity of structure, by contiguity of structure, by the blood, and by the lymphatics. Extension by continuity is seen in phlebitis. Extension by contiguity is seen when a cutaneous inflammation advances and attacks deeper structures. Extension by the blood is seen in the formation of the smallpox exanthem. Extension by the lymphatics is witnessed in a bubo following chancroid.

Terminations of Inflammation.—Inflammation may be followed by a return of the tissues to health, and this return may take place by delitescence, by resolution, or by new growth. By delitescence is meant abrupt termination at an early stage, as when a quinsy is aborted by the administration of quinin and morphin, and the production of a sweat; resolution means the gradual disappearance of the symptoms when inflammation has passed through its regular stages; and new growth means that an inflammation has lasted a considerable time, with ample blood-supply, and without suppuration and has gone on to the formation of fibroblasts, granulation tissue, and fibrous tissue. Inflammation may be followed by death of the inflamed part, or necrosis. Death of the part may be due to suppuration, ulceration, or gangrene.

The causes of inflammation are—predisposing, or those residing in the tissues, and rendering them liable to inflame; and exciting, or those which directly awake the process into activity. The first may be thought of as furnishing inflammable material; the second may be regarded as sparks of fire

Predisposing causes are those which impair the general vigor, injure the blood, weaken the tissues, or lower nutritive activities. Among these causes are shock, hemorrhage, nervous irritation, gout, rheumatism, diabetes, Bright's disease, alcoholism, and syphilis. Plethora renders a person liable to sthenic inflammations (those characterized by high action). Tissue debility renders one prone to adynamic or asthenic inflammations. Nerve injury predisposes to inflammation, either from damage to trophic nerves and consequent failure in tissue nutrition and resistance or because analgesia exists and irritants which reach the region are not recognized and are allowed to remain. For instance, if the conjunctiva is in a condition of analgesia, the presence of foreign bodies is not noticed and destructive inflammation may result from their non-removal.

After removal of the Gasserian ganglion the cornea is devoid of sensation, the flow of tears is lessened, dust gathers in the eye, and if not removed by irrigation or kept out by a shield inflammation and disastrous ulceration will ensue.

Exciting Causes.—The exciting causes of inflammation are—traumatic, as blows and mechanical irritation; chemical, as the stings of insects, the rubefacient effects of mustard, venom of serpents, products of bacteria, ivy poison, etc.; thermal, heat and cold; specific, the micro-organisms, causing, for instance, tuberculous peritonitis or erysipelas; and nervous, nerve stimulation certainly being capable of producing hyperemia and sometimes even inflammation. Inflammation due to nerve stimulation is seen in herpes zoster and in the swollen and discolored skin over an inflamed joint (Adami). Inflammation may also be induced by electric currents, by the x-rays, by radium rays, and by the actinic rays of sunlight and of electric light.

Some writers insist that every inflammation is due to the action of microorganisms, but this statement lacks proof. They maintain that inflammation is a destructive microbic process which cannot bring about repair, and that repair begins only when inflammation ends. As Adami points out, the advocates of this view argue that swelling, pain, and discoloration point to the existence of inflammation; that repair can take place when these phenomena

are absent, hence inflammation is not present when repair begins. As a matter of fact, swelling, discoloration, and pain are phenomena often but not invariably associated with inflammation; and in inflammation one or all of these phenomena may be absent. Because these signs are not discovered is no proof that inflammation does not exist. I believe that inflammation is not always due to microbes and is not always a destructive process, but may be from the start conservative and reparative. It is the reaction of the tissue to injury and is the first step on the road to repair.\*

Symptoms of Acute Inflammation.—Inflammation, if at all severe, announces its presence by symptoms which are both *local* and *constitutional*. The local symptoms are heat, pain, discoloration, swelling, disordered function, and in some regions muscular rigidity; the chief constitutional symptom is fever.

Local Symptoms of Inflammation.—The most prominent local symptoms were known centuries ago to the famous Roman, Celsus, who stated them as "rubor, calor cum tumore et dolore"—redness and heat with swelling and pain. As set forth to-day, the local symptoms are—(1) heat; (2) pain; (3) discoloration; (4) swelling; (5) disordered function; and (6) muscular rigidity, which is noted in inflammation of certain regions and structures.

Heat is due to the passage of an increased quantity of blood through the damaged area and to the arrival at the surface of the body of warm blood from internal parts. Although an inflamed part may be, and usually is, warmer than the surrounding parts, its temperature is never greater than the temperature of the blood. This increase of heat is especially noticeable when we, for instance, touch an arm affected with erysipelas and contrast the sensation obtained with that obtained by placing the hand on the sound arm. The diseased arm feels much warmer to the examining hand than does the sound arm, but its temperature is not above the general body-temperature. An extremity in health, as is well known, shows on the surface a temperature below that of the blood; in an inflamed state the temperature may nearly equal that of the blood. Heat is always present in inflammation of a superficial part. The surgeon examines for heat by placing his hand upon the suspected area and then placing it upon a corresponding portion of the opposite side of the patient in order to note the contrast. If great accuracy is desired, a surface thermometer is used.

Pain is a constant and conspicuous symptom. It is due to stretching of or pressure upon nerves from exudate; to irritation of nerves; or to inflammation of the nerves themselves, producing cellular changes. Pain is associated with tenderness (pain on pressure), it is aggravated by motion and by a dependent position of the part, and it varies in degree and in character. In serous membranes it is acute and lancinating, like dagger-thrusts; in connective tissue it is acute and throbbing; in large organs it is dull and heavy; in the bone it is gnawing or boring; in the skin and mucous membrane it is itching, burning, smarting, or stinging; in the urethra it is scalding; in the testicle it is sickening or nauseating; in the teeth it is throbbing; and in inflammation under dense fascia it is pulsatile. Pain in inflammation after presenting itself in one form may change in character. If a pain becomes markedly throbbing, suppuration may be anticipated. Pain does not always occur at the seat of trouble, but may be felt at some distant point. This is

<sup>\*</sup>See Adami's masterly article in Allbutt's "System of Medicine."

known as a "sympathetic" pain, and is due to the fact that the area to which pain is referred receives its nerve-supply from the same spinal segment as does the inflamed area, in other words, there is a nervous communication between the inflamed part and a distant area. In most cases of sympathetic pain a nerve-trunk refers the sense of pain to its peripheral distribution but sometimes pain is referred to an adjacent nerve, a distant nerve, or even, perhaps, to a nerve on the opposite side of the body. Tenderness, however, is detected at the seat of trouble and not at the seat of referred pain.

Pain of hepatitis is often felt in the right shoulder. Pain at the point of the shoulder or in the shoulder-blade is felt also in gall-stones and in cancer of the liver. The pain arises in filaments of the pneumogastric from the hepatic plexus, which filaments reach the spinal accessory, pain being expressed in the branches of the spinal accessory which supply the trapezius and communicate with the third and fourth cervical nerves.\*

Pain of coxalgia is often felt on the inside of the knee, because the obturator nerve, which sends a branch to the ligamentum teres, also sends a branch to the interior and to the inner side of the knee-joint.

Inflammation of an eye with increased tension causes browache. Inflammation of the neck of the bladder causes pain in the head of the penis. Inflammation of a testicle cause pain in the groin. Renal calculus and pyelitis cause pain in and retraction of the testicle, and pain in the loin, groin, or thigh.

If the covering of an organ is involved, pain becomes more violent; for instance, hepatitis becomes much more painful when the perihepatic structures are attacked. Inflammation without pain is known as "latent" (as the inflammation of Peyer's patches in typhoid). The sudden disappearance of inflammatory pain, when not due to the administration of opiates, suggests the possibility of gangrene, because analgesia exists in gangrene. The characteristics of inflammatory pain are that it comes on gradually, has a fixed seat, is continuous, is attended by other inflammatory symptoms, and is increased by motion, by pressure, and by a dependent position of the part. If there be no tenderness in a part, the source of the pain is not local inflammation; but tenderness may exist when there is no local inflammation, as in pain referred from a distant part. Pain of inflammation does not correspond to an exact nervous distribution. If pain corresponds exactly to the area of a nerve's distribution, the cause of it is acting on the nerve'-trunk or on its roots. If the cutaneous surface is involved, the lightest touch causes pain. If touching the skin produces no pain, but deep pressure does produce it, the deeper structures are the source. Pain in muscle and ligament is developed by motion; in muscle, by contraction, but not by passive movements with the muscle relaxed; in ligament pain is developed by active or passive movements which stretch the ligament. If, for example, a man with a stiff neck has pain on the right side of the back of his neck on voluntarily turning his face toward the left shoulder, but is without pain when his face is turned by the surgeon, who, conversely, induces pain by turning the patient's face far to the right, this condition indicates the trouble to be muscular. If, however, no pain arises on turning the face to the right, but it is manifest on turning the face actively or passively to the left, the pain is in those ligaments which stretch

<sup>\*</sup>Embleton's view in Hilton on "Rest and Pain," a book every student should read.

when the face is turned to the left.\* In inflammation of the synovial membrane gentle passive motion in any direction causes pain.

The pain of colic differs from that of inflammation. It is sudden in onset, intermits, recurs in paroxysms, and is relieved by pressure. The pain of inflammation is gradual in onset, is continuous, and is made worse by pressure. The pain of neuralgia is often preceded by cutaneous anesthesia of the skin of the part, is very paroxysmal, comes on suddenly, darts through recognized nerve-areas, the attack lasts some hours, and is apt to recur at a certain hour. It presents no general tenderness, as does inflammation, but we may find serveral points which are acutely sensitive to pressure (Valleix's points douloureux). The tender spots of Valleix are met with in inveterate neuralgia, and occur at points where nerves "pass from a deeper to a more superficial level, and particularly where they emerge from bony canals or pierce fibrous fascise."†

Pain is often of great value by calling attention to parts diseased; but it may be a terrible evil, racking the organism and even causing death. If pain continues long, it becomes in itself formidable: it prevents sleep, it destroys appetite, and it deteriorates the mind, and one of the surgeon's highest duties is to relieve it. The physiognomy or expression of physical pain presents the following characteristics: Heavy fulness about the eyes, and dropping of the angles of the mouth, added to appearance due to anemia, widespread tremor, etc. The absence of the physiognomy of pain in a person who complains of great agony is a strong indication that the patient exaggerates the gravity of his sufferings or deliberately deceives.

Discoloration arises from determination of blood to the part; hence the more vascular the tissue, the greater the discoloration. A non-vascular tissue presents no discoloration, though we usually find discoloration adjacent in the zone of blood-vessels which furnish the tissue with nutriment. Discoloration is most intense at the focus or center of inflammatory action. Discoloration varies in tint and in character according to the tissue implicated and the nature of the inflammation. It may be circumscribed or diffuse. Arborescent redness means a distribution in dendritic lines. Linear discoloration signifies redness running in straight lines, as in phlebitis. Punctiform discoloration occurs in points, and is due to vascular rupture. Maculiform redness resembles an ecchymosis or blotch. Dusky discoloration points to suppuration.

Inflammation of the throat and skin produces scarlet discoloration; inflammation of the sclerotic coat of the eye and of the fibrous coat of muscle produces lilac or bluish discoloration; inflammation of the iris produces brickdust, grayish, or brown discoloration; erysipelas causes a yellowish-red discoloration; secondary syphilis causes a copper-hued discoloration; and tonsillitis causes a livid discoloration. A tuberculous ulcer is of a purple color on the edge. Gangrene is shown by a black discoloration. A scorbutic ulcer is surrounded by an area of violet color.

Redness as a sign of inflammation must be permanent and joined with other symptoms. Redness due to inflammation disappears on pressure, but returns as soon as the pressure is removed. If redness is due to staining of the surface by dye, pigmentation, or extravasation of blood, pressure will not

<sup>\*&</sup>quot;Surgical Diagnosis," by A. Pearce Gould. † Anstie, "Neuralgia and Diseases which Resemble It."

blanch the spot. If on taking off pressure the redness of inflammation rapidly returns, the circulation is active; if, on the contrary, it very slowly reappears, the circulation is very sluggish and gangrene is threatened. Subcutaneous hemorrhage gives rise to a purple-red color which does not fade when subjected to pressure. Stains of the surface by dyes fail to disappear on pressure, are distributed over a considerable surface, show a hue which is uniform throughout, are obviously superficial, are not associated with other signs of inflammation, and can be washed away.

A. Pearce Gould, in his excellent little work upon "Surgical Diagnosis," tells us that the color of a hyperemic surface may furnish important information. Lividity may mean failure of the heart and lungs, or simply venous congestion in the part. In lividity from obstruction of the lungs or heart the color slowly returns after pressure has driven it out. In lividity due to local congestion the color quickly returns when pressure is released and the dilated veins are often distinctly visible. Of course, in a local trouble, when the circulation becomes impaired to such a degree that gangrene is threatened, the lividity fades very slowly on pressure and reappears very slowly on the release of pressure.

Swelling or tumejaction arises in small part from vascular distention, but chiefly from effusion and cell-multiplication. The more loose cellular material a part contains, the more it swells; hence the eyelids, scrotum, vulva, tonsils, glottis, and conjunctivæ swell very largely when inflamed. A swelling is soft or edematous when due to uncoagulable effusion; is brawny and doughy when due to coagulated effusion; is hard and elastic when produced by proliferating cells. Swelling may do good by unloading the vessels and acting like a blister or local bleeding, or it may do great harm by pressing upon the vessels and cutting off the blood-supply. Swelling of the conjunctiva, or chemosis, may cause sloughing of the cornea, and swelling of the prepuce may cause gangrene. A swelling may do harm by obstructing a natural passage, as in edema of the glottis, when the larynx becomes blocked; or by compression of a normal channel, as in the swelling of the perineum, when the urethra is compressed. A swollen area may be covered with blisters or blebs. This condition is noted particularly in burns and fractures.

Disordered function is always present in inflammation. It may be manifested by increased tenderness or sensibility, a slight touch, it may be, producing torturing pain. Parts almost or entirely destitute of feeling when healthy (as tendons, ligaments, and bones) become highly sensitive when inflamed. It may be manifested by increased irritability. In dysentery the colon repeatedly contracts and expels its contents; the stomach does likewise in gastritis; and the bladder acts similarly in cystitis. Spasmodic twitching of the eyelids occurs in conjunctivitis, and twitching of the muscles of a limb in fracture and after amputation.

Impairment of Special Function.—In inflammation of the eye, when an attempt is made to look at objects, the lids close spasmodically, and even a little light causes great pain and lachrymation (photophobia). In inflammation of the ear noises cause great suffering, and even when in a quiet room the patient has subjective buzzing and roaring in his ears (tinnitus aurium). In coryza the sense of smell, in glossitis the sense of taste, in dermatitis the sense of touch, and in laryngitis the voice may be lost. In inflammation of

the brain the mind is affected; in arthritis the joints can scarcely be moved; and in myositis it is difficult and painful to employ the muscles.

Derangement of Secretions.—In dermatitis the sweat is not thrown off; in hepatitis bile is not properly secreted; and in nephritis urea is not satisfactorily removed. The secretions may undergo important changes of composition. The sputum in pneumonia is rusty, and dysentery causes a discharge of bloody mucus (Gross).

Derangement of Absorbents.—In the height of an inflammation the absorbents are blocked and clogged by coagulated exudate, and they cannot perform their offices.

Muscular rigidity is sometimes an important sign of inflammation. If a joint is inflamed the muscles which move the joint are rigid and the joint is more or less immobile. In inflammation of the peritoneum the abdominal muscles are rigid and the respirations become shallow, frequent, and thoracic. In pleuritis the intercostal muscles of the inflamed side become rigid and the respiratory excursion of the chest is limited. Rigidity serves to lessen motion,

prevent pain, protect the part, and so give physiological rest.

Constitutional symptoms of acute inflammation may be absent, and often are in moderate or limited inflammations; but in severe, extensive, or infective inflammations the symptom group known as Jever is certain to exist. This is known as symptomatic, or inflammatory fever, and it arises in non-septic cases from the absorption of aseptic pyrogenous exudate and in microbic inflammations from the absorption of pyrogenous toxic products of bacterial action. In young and robust individuals an acute non-microbic inflammation causes a fever characterized by full, strong pulse, flushed face, coated tongue, dry skin, nausea, constipation, and possibily acute delirium (the sthenic type of the older authors). In broken-down and exhausted individuals an ordinary inflammation, and in any individual a bacterial inflammation, may cause a fever with typhoid symptoms (the typhoid, asthenic, or adynamic type). Fibrin ferment is obtained from the white corpuscles; it is liberated as the corpuscles break up in the exudate, and acting on the liquor sanguinis cause the union of calcium and fibrinogen and the formation of fibrin. The absorption of fibrin ferment many believe causes aseptic fever (page 134). Inflammatory blood contains an increased amount of albumin and salts. If a person with inflammatory fever is bled, the blood coagulates rapidly, the clot sinks, and there is found on the surface a cup-shaped coat, made up of liquor sanguinis and white cells, known as the "buffy coat"; but this is not really a sign of inflammation, and occurs normally in the blood of the horse. The buffy coat forms when blood contains a great number of leukocytes, because these leukocytes sink more slowly than do the red corpuscles. Cupping occurs because the white corpuscles sink more slowly by the side of the tube than far from the sides.

Leukocytosis.—In many inflammatory and infectious diseases leukocytosis is noted. It probably indicates an attempt on the part of the organism to protect itself from noxious materials. Leukocytosis is usually much more marked if pus exists than if the exudation is serous or fibrinous.

"The degree of leukocytosis may be considered a general index to the intensity of the infection and to the strength of the individual's resisting powers in reacting against it. If follows, therefore, that intense infections occurring in individuals whose resisting powers are strong, produce a decided increase; but the presence of an infection of like intensity in one whose resisting powers are greatly crippled fails to cause leukocytosis, for in such an instance the organism is so overpowered by the effects of the morbid process that it is incapable of reacting " ("Clinical Hematology," by J. C. DaCosta, Jr.). We see from the above that gangrene or any other virulent infection may be accompanied by a low leukocytic count, and when pus is surrounded by a thick wall the leukocytes may be normal in number. An increased proportion of polymorphonuclear leukocytes strongly suggests body reaction against infection, and an increase of eosinophiles aids us in recognizing deep-seated pus when the leukocyte count is normal or but slightly increased.

The introduction of salt solution into the peritoneal cavity leads to the gathering of numbers of white cells and the resistance of the serous membrane to infection is increased. Horse serum that has been boiled is said by Petit to be a valuable material to draw polynuclear leukocytes to a part ("Med. Record," June 22, 1907). It has been injected into the peritoneal cavity the evening before an operation (30 cc.); it has been poured into the cavity at the termination of an operation; the gauze used for drainage after an appendicitis operation has been soaked in it.

There is no fixed number of leukocytes which causes us to affirm the presence or absence of gangrene or pus. Deaver thinks that a relative percentage of polynuclear cells below 70 in blood showing any degree of inflammatory leukocytosis indicates excellent tissue reaction and the absence of pus and gangrene ("N. Y. Med. Jour.," Feb. 2, 1907). Most serious inflammations show marked inflammatory leukocytosis and an increase in the relative proportion of polynuclear cells. Typhoid shows no leukocytosis and even a mixed infection shows comparatively little increase of polynuclear cells. The same is true of tuberculosis. The same man should make all the counts on one patient; at least 500 cells should be counted and several examinations ought to be made.

Chronic Inflammation.—This condition results from the action on the tissues of some mild but long acting irritant. It progresses slowly and does not produce symptoms of severity either in the part or the body at large.

Causes.—Blood diseases, as rheumatism and gout; infective diseases, as tuberculosis and syphilis; retained pus in an ill-drained abscess; blocking of the duct of a gland; the retention of a foreign body in a part; the flow of an irritant secretion (as saliva from a fistula); repeated identical traumatisms of an occupation, etc. W. Watson Cheyne tells us that chronic inflammation is not due to the ordinary pyogenic organisms (see Cheyne's article in Treves's "System of Surgery").

Tissue-changes.—These changes are practically the same as in acute inflammation, but take place far less rapidly. Vascular dilatation, exudation, and leukocytic migration are often trivial. Cell proliferation is always conspicuously marked. It is maintained by Cheyne and others that typical granulation tissue does not form, the tissues of the part being replaced directly by fibrous tissue. The amount of fibrous tissue produced is relatively very great. This tissue may cause permanent thickening, or may contract and thus diminish the size of a part. Contraction is very considerable in cirrhosis of the liver and in interstitial nephritis.

Symptoms.-Pain varying in intensity and character; tenderness; great swelling, which in some cases is followed by shrinking, and is usually indurated or brawny. As a matter of fact, great swelling is the most usual symptom. Sometimes there is a trivial amount of heat. There is rarely discoloration unless the skin is itself inflamed, but usually the surface veins are distinctly and sometimes they are greatly distended. There are no constitutional symptoms attributable purely to the inflammation. If there are such symptoms, they are due to the disease which induced the inflammation or to interference with the function of an organ because of the fibrous mass. (For the treatment of chronic inflammation see articles upon special regions and particular structures.)

Treatment of Acute Inflammation.—The first rule in treating an inflammation must be to remove the exciting cause. If this cause is a splinter in the part, take out the splinter; if it is a foreign body in the eye, remove the foreign body; if urine is extravasated, open and drain; take off pressure from a corn; pull out an ingrown nail; and remove microbes from an infected area by exposing, irrigating, and applying antiseptics. The rule, remove the cause, applies to a chronic as well as to an acute inflammation. If the cause of an inflammation was momentary in action (as a blow), we cannot remove it, for it has already ceased to exist. After removing the cause, endeavor to bring

about a cure by local and constitutional treatment.

Local Treatment of Inflammation.—It must be remembered that the division of inflammation into stages is natural, and not artificial, and that a remedy which does good in one stage may do harm in another. Certain agents are suited to all stages of an acute inflammation, namely, rest and elevation. In many inflammatory conditions Nature seeks to immobilize, protect, and rest the part by increasing the tension of adjacent muscles. By this muscular rigidity inflamed joints are fixed and rested. Rigidity of the intercostal muscles in pleuritis limits chest motion and pain; rigidity of the abdominal muscles in peritonitis limits abdominal movements and lessens suffering.

Rest.—Physiological rest is of infinite importance, and is always indicated in acute inflammation. In the exercise of function blood is taken to a part and an existing inflammation is aggravated. Further, as Billroth has pointed out, rest prevents the dissemination of infection, because motion exposes fresh surfaces to inoculation and breaks down protective barriers of leukocytes. Its principles were first thoroughly studied by Hilton.\* Baron Larrey, the celebrated military surgeon of the Napoleonic Empire, anticipated many modern views on this subject. He insisted on the necessity of rest in the treatment of wounds; he believed that rest permitted Nature to perform her work unhampered; he was accustomed to leave a "first dressing," if properly applied, undisturbed for several or even for many days. He believed it advisable to associate with rest well adjusted and judicious compression made by bandages, especially flannel bandages. (The author on Baron Larrey, in "Johns Hopkins Hospital Bulletin," July, 1906.) The means of securing rest differ with the structure or the part diseased. When rest is used, do not employ it too long. Rest in bed diminishes the amount of blood sent to an inflamed part and lessens the force of the circulation; hence it antagonizes stasis. It has been shown that the heart beats at least fifteen

<sup>\*&</sup>quot;Lectures upon Rest and Pain."

times per minute less when the patient is recumbent than when he is erect. The saving of strength and the benefit to the local condition are thus seen to be enormous. In fact, the heart saves at least twenty-one thousand beats a day. In every severe inflammation insist on the patient going to bed.

In cerebral concussion rest must be secured by quiet, by darkness, by the avoidance of stimulants and meat, by the application of ice to the head, and by the use of purgatives to prevent reflex disturbance and the circulation of poisons in the blood. In *inflamed joints* rest must be obtained by proper position, associated in many cases with the adjustment of splints or plaster-of-Paris, or the employment of extension.

In pleuritis partial rest can be secured by strapping the affected side with adhesive plaster or by using a bandage or a binder to limit respiratory movements. In fractures Nature procures rest by her splints-the callus-and the surgeon procures rest by his splints-firm dressings, or extension. In cancer of the rectum and intractable rectitis a colostomy secures rest for the inflamed and damaged bowel. In enteritis opium gives rest to the bowel by stopping peristalsis. In cystitis rest is obtained by the administration of opium and belladonna, which paralyze the muscular fibers of the bladder. The use of the catheter gives rest to the bladder by removing urine. A cystotomy allows complete rest by permitting the bladder to suspend its function as a reservoir of urine. In cystitis from vesical calculus rest is obtained by incising and draining the bladder or by crushing and evacuating the stone. In infamed mucous membrane rest from the contact of irritants is secured by touching the membrane with silver nitrate, which forms a protective coat of coagulated albumin. Opening an abscess gives its walls rest from tension. In inflammations of the eye light must be excluded to obtain complete rest, but tolerably satisfactory rest is given in some cases by the use of glasses of a peacock-blue tint. In aneurysm the operation of ligation cuts off the bloodcurrent and gives rest to the sac. In hernia the operation gives rest from pressure. Instances of the value of rest could be multiplied indefinitely.

Relaxation is in reality a form of rest, and consists in placing the part in an easy position. In synovitis of the knee semiflexion of the knee-joint lessens the pain. In muscular inflammations relaxation relieves the pain.

Elevation.—Elevation partly restores circulatory equilibrium. A felon is less painful when the hand is held up in a sling than when it is dependent. A congestive headache is worse during recumbency. A gouty inflammation in the great toe is more painful with the foot lowered than when it is raised. A loothache becomes worse on lying down.

Certain agents are suited to the stage of vascular engorgement, increased arterial tension, and beginning effusion. These agents are—(1) local bleeding or depletion; (2) cutting off the blood-supply; and (3) cold.

Local Bleeding.—Local bleeding, or depletion, is the abstraction of blood from the inflamed area. This abstraction relieves circulatory retardation and causes the blood to move rapidly onward; the corpuscles clinging to the vessel-walls are washed away, the capillaries shrink to their natural size, and the exudate is absorbed. In other words, local blood-letting increases the rate of the circulation, though not its force.

The methods of bleeding locally are—(a) puncture; (b) scarification; (c) leaching; and (d) cupping.

Puncture is recommended in inflammation, not only because it abstracts blood locally, but also because it gives an exit to effusion under fibrous membranes. It is very useful in relieving tension—for instance, in epididymitis. It is performed with a tenotome and with aseptic precautions. If numerous punctures are made, the procedure is termed "multiple puncture." This is very useful when applied to the inflamed area around a leg-ulcer. The late Prof. Joseph Pancoast was very fond of employing multiple punctures, designating the operation "the antiphlogistic touch of the therapeutic knife."

Scarification or Incision.—By means of scarification we bleed locally, evacuate exudate, and relieve tension. One cut or many cuts may be made, and these cuts may be deep or may not go entirely through the skin, according to circumstances. Multiple incisions are useful when applied to inflamed ulcers, ulcers in danger of gangrene, and to almost any condition of great tension. Scarification is of notable value when edema of the glottis exists. Free incision is of great benefit in periostitis and in threatened gangrene. In osteo-

myelitis the medullary canal must be promptly opened.

Leeching.-Leeches must not be applied to a region plentifully endowed with loose cellular tissue, as great swelling and discoloration are sure to ensue. These regions are the prepuce, labia majora, scrotum, and evelids. Leeches should never be applied to the face (because of the scar), near specific sores or inflammations, nor over a superficial artery, vein, or nerve. A leech is best applied at the periphery of an inflammation and between an inflammation and the heart. To leech at the inflammatory focus only aggravates the trouble. Before applying leeches, wash the part and shave it if hairy. Place the leech in a test-tube or an inverted wine glass, inserting the tail or thick end first, and invert the tube so that the leech's head will come in contact with the prepared skin. The leech is restrained in the tube until it "takes hold" and begins to feed, when the tube is removed. If the leeches will not bite, smear the part with milk or a little blood. Never pull off a leech; let it, drop off. It will usually drop off when full, but if it refuses to do so, sprinkle it with salt. After removing a leech, employ warm fomentations if continued bleeding is desired. Sometimes the bleeding persists, but this may be arrested by styptic cotton and pressure. In some rare cases the bleeding continues in spite of



Fig. 49.—Rubber bulb cupper.

pressure. This is due to the fact that the tissue contains a considerable quantity of a material secreted from the throat of the leech, which material prevents coagulation of blood. In such a case excise the bite and the area of tissue adjacent to it, and suture the wound. Leeching leaves permanent triangular scars. The Swedish leech, which is preferred to the American, draws from two to four drams of blood. After a leech has been removed, if we desire to use it again, place it in salt water. This causes it to vomit the blood which it has taken up. Leeching has both a constitutional and a local effect. It is at present used comparatively rarely, but it is employed by some practitioners over the spermatic cord in epididymitis, on the temple in ocular inflammation, and

over the right iliac region to relieve pain in mild cases of appendicitis.

Cupping.—Dry cups deviate blood from a deeply placed inflamed area to the surface. Wet cups actually remove blood.

Dry Cups .- Dry cups are applied without first incising the skin. One or more may be applied. A special instrument is sold in the shops for the performance of dry cupping. It consists of a glass bell, with a globular and hollow top of rubber (Fig. 49). The rubber bulb is emptied of air by squeezing, the glass bulb, the edges of which have been greased, is pushed upon the skin, and the compression is relaxed upon the rubber bulb. A partial vacuum is created, and an area of skin and subcutaneous tissue full of blood rises into the glass bell.

Cupping can be easily performed by means of a tumbler. The edge of the glass is greased; a bit of blotting-paper wet with alcohol is placed in the bottom of the tumbler and lighted. After a brief period the glass is inverted and placed upon the skin, which has been dampened with warm water. As the air in the glass cools, the tissues rise into the partial vacuum.

Wet Cups.—Wet cups draw blood, and the skin should be cleansed before they are applied. In wet cupping apply a cup for a moment, remove it, incise



Fig. 50 -- Scarificator.

Fig. 51.-Heurteloup's artificial leech.

or puncture the skin, and replace the cup to draw the requisite amount of blood. Incisions may be made by an ordinary scalpel, a lancet, or a scarificator, a cup being then applied. An excellent scarificator is shown in Fig. 50. In this instrument concealed blades are thrown out by touching a spring. Baron Heurteloup devised an instrument (Fig. 51) in which the incision is made by a scarificator. The blood is drawn out by a pump, the tube being placed upon the cut area and the withdrawal of the piston creating a vacuum. This instrument is known as the "artificial leech." After scarification and the application of the cup, the partial vacuum draws blood into the cup; when the surface ceases to bleed, the cup is removed, and if further bleeding is thought desirable, the clots are wiped away and the cup is again applied, and after its removal warm fomentations are used (Cheyne and Burghard). Wet cupping is of value in pleuritis, pericarditis, and nephritis.

Cutting off the Blood-supply.-Onderdonk, of New York, in 1813 recommended ligation of the main artery of a limb for the cure of inflammation in important structures supplied by the vessel. The procedure was warmly advocated by Campbell, of Georgia, for the treatment of gunshot wounds of joints. This plan of treatment is now not to be considered for a moment; antisepsis furnishes us with a safer and more certain plan. Vanzetti, of Padua, advocates digital pressure to cut off the blood-supply to an

inflamed part.

Cold.-Cold is a very powerful and useful agent if used judiciously and applied at the proper time. It is valuable because of its reflex effect upon the vessels of the inflamed area rather than because of direct action upon the cells of a part. It should be used early in the case, before stasis occurs. It is not to be used in the later stages of inflammation, for it will then only aggravate the existing state; in fact, when there is considerable exudation cold does no

good.

Cold acts by constricting the vessels of a hyperemic area, thus lessening the amount of blood sent to the part, and preventing the evolution of the process into the stage of stasis and exudation. Further, it prevents the migration of leukocytes, retards cell-proliferation, relieves pain and tension, and lowers temperature. If cold is too intense, if it is kept too long applied, if it is used late in an inflammation, if it is used upon an old or feeble patient, or if it is employed when there is much exudation or a condition of tissue strangulation, it does actual harm. It lessens the nutritive activity of cells, constricts the lymph-spaces and channels, increases existing stasis, and hence lowers the vitality of the tissues. If the parts are constricted, as in strangulated hernia, or if they are compressed by a large exudate, or fed by diseased blood-vessels, cold may cause gangrene. Nancrede, in his "Principles of Surgery," points out that in an inflammation stasis soon arises at the focus of the inflammation, and there is an area of stasis surrounded by a zone of hyperemia. benefits the hyperemic zone but aggravates the stasis. Nancrede cautions us as follows: "Judgment is therefore requisite to decide whether the evil at the focus will not outweigh the good exerted at the periphery." \* Nancrede further points out that cold must not be used intermittently; but if employed at all, must be continuously applied. If cold is applied intermittently, there will be a reaction whenever it is removed, and this reaction causes increased hyperemia. Hence, cold must be "continued in action to prevent reaction." If during the employment of cold the skin becomes purple and congested and the circulation feeble, at once discontinue the use of it, as its continuance will be dangerous.

Cold may be used as wet cold or as dry cold.

Wet Cold.—Wet cold is easily applied, but it is much more depressing than dry cold, is likely to produce discomfort, macerates the skin, and may lead to the formation of excoriations, etc. A part can be subjected to wet cold by the application of evaporating fluids or the use of a siphon. When wet cold is used inspect the part at frequent intervals, and discontinue the treatment if evidences of stasis become positive. Evaporating fluids are extensively employed. If such a fluid is used, never cover the part with a thick dressing. If this should be done, the fluid will not evaporate with sufficient rapidity to produce cold. A piece of thin muslin or flannel should be moistened with the fluid and laid upon the part, and be kept constantly moist by the application from time to time of small quantities of the liquid. Lead-water and laudanum is used extensively, and probably owes its chief value to the fact that it produces cold on evaporation. Lead-water and laudanum is composed of 3j of laudanum, 3j of liquor plumbi subacetatis, and 1 pint of water. Liquor plumbi subacetatis dilutus may be used without laudanum. It is thought that the addition of laudanum tends to allay pain. A solution of ammonium chlorid may be used in the strength of 3j of the drug to 2 quarts of water. If ammonium chlorid is used for more than a short period of time, it is prone to

<sup>\* &</sup>quot;Principles of Surgery."

cause the formation of blisters which are irritable and painful. Cheyne and Burghard use the following formula: ½ ounce of ammonium chlorid, I ounce of alcohol, and 7 ounces of water. Plain spring-water, iced water, or a mixture of alcohol and water may be used. The siphon is occasionally used. If there is a wound, the fluid must be aseptic or antiseptic. In conjunctivitis, cold is applied to the eye by means of linen or muslin soaked in iced water laid upon the closed lids, and changed frequently.

To apply wet cold by means of a siphon, the part is covered with one layer of wet linen or muslin and is laid upon a rubber sheet folded like a trough and emptying into a bucket. A vessel filled with cold water is placed upon a higher level than the bed. A wet lamp-wick is now taken, one end is inserted into the water of the vessel, and the other end is laid upon the part. Capillary action and gravity combine to keep the part moist. A rubber tube may be used instead of a wick. If a tube is employed, tie it in a knot or clamp it so that the fluid is delivered drop by drop (Fig. 53). Ordinary water or iced water can be used. If the water be too warm, it can be reduced to about 45° F. by adding 1 part of alcohol to every 4 parts of water. A mixture of 5 parts of nitrate of potassium, 5 parts of chlorid of ammonium, and 16 parts of water produces great cold.

Dry cold is more manageable and more generally useful than wet cold. It is applied by means of a rubber bag or a bladder filled with ground or finely cracked ice, several folds of flannel being first laid over the part. The flannel collects the moisture from the "sweating" bag and thus prevents maceration of the skin. Further, it saves the tissue from being subjected to too much direct cold and enables us to obtain the beneficial reflex effect. The ice-bag of India-rubber is widely used. We can venture to apply by means of the ice-bag a greater degree of cold than it is proper to apply by the use of fluids, as dry cold is not so likely to induce gangrene as is moist cold. If there is much tenderness, the weight of an ice-bag causes pain, and it is best to suspend it from a frame, so that it lightly touches the part. The frame is the same as is

used to keep the bedclothes from a fractured leg, and can be easily made from barrel hoops. During the time an ice-bag is being used the part must be inspected at brief intervals to see that the circulation is not unduly depressed. The ice-bag is frequently used in joint-inflamma-



Fig. 52,-Ice-bag (W. E. Ashton).

tion, in intracerebral inflammation, in the earliest stage of appendicitis (see page 999), in epididymitis, and in acute myelitis. If a joint is sprained, the immediate application of an ice-bag is of great service. A part can be encircled with a rubber tube through which iced water is made to flow (Fig. 54). Even when this apparatus is used the part should first be wrapped in flannel. Leiter's tubes, which are tubes of lead made to fit various regions and which carry a stream of cold water, can also be used. A piece of flannel must be placed between the tube and the skin. The temperature of these tubes can be lowered to any desired degree by lowering the temperature of the circulating fluid. Cheyne and Burghard caution us to use a fluid at a temperature not

under 50° or 60° F., to inspect the part every three or four hours, and not to employ the tubes longer than twenty-four hours.



Fig. 53.-Siphon (Esmarch).

Heat is employed by some early in an inflammation. It is rarely beneficial at this stage, except when applied by a hot-air apparatus for the treatment of



Fig. 54.—The Esmarch cooling coil.

an injured joint. It is true that a degree of heat which does not actually destroy the tissues will contract the vessels as does cold; but this degree of heat will not be borne by the patient unless but a limited portion of a superficial part is involved.

Certain agents are suited to the stage of fully developed inflammation, when there is a great deal of swelling due to effusion and cell-proliferation. The indication in this stage is to abate swelling by promoting absorption. This

is accomplished by (1) compression; (2) local use of astringents and sorbefacients; (3) the douche; (4) massage; and (5) heat.

Compression.—Compression is especially useful in fully developed or in chronic inflammation, but it will do good even in the early stages. Compression is of great usefulness; it supports the vessels and causes them to drink up effusion, and it strongly rouses the absorbents. This agent is valuable in most external inflammations with marked swelling and is particularly beneficial in chronic inflammation. In erysipelas of an extremity the part should be elevated and the extremity bandaged from the periphery to the body. In ulcers, especially those with hard and blue edges, the use of Martin's elastic bandage or of straps of adhesive plaster gives decided relief. In chronic infammation of a joint elastic compression is of great value. In epididymitis, after the acute stage, the testicle may be strapped with adhesive plaster. In lymphadenitis compression by a weight or by a bandage is very generally employed. In fractures compression not only antagonizes spasm, but often combats the swelling and pain of inflammation. Compression must be judicious; it must never be forcible, and it must not be applied to a limb without including the distal portion of the extremity (never, for instance, strongly compress the elbow without including the hand, nor the palm without bandaging the fingers). Injudicious compression causes severe pain and great edema, and may produce gangrene.

Astringents and Sorbefacients.-Astringents may have direct value in inflammation of the skin, but it is not likely that they have any effect on deepseated inflammation. When used in evaporating lotions in an earlier stage of inflammation the cold does good rather than the drug. Lead-water and laudanum is extensively employed and it is thought to somewhat allay inflammatory pain. The mixture certainly gives comfort in cutaneous erysipelas. It is very doubtful if lead-water is of any service at any stage of a deep-seated inflammation or in any fully developed inflammation. If used after the first stage it must not be applied as an evaporating lotion, because cold will do harm. Pieces of lint are soaked in the fluid and placed upon the part, and a bandage is applied. The wet lint which has been placed upon the part is covered with oiled silk or a rubber dam before the bandage is applied. If used in the latter manner, the body-heat is retained in the part. If greater heat is required, a hot-water bag can be placed outside of the bandage. Lead-water is not used in treating wounds and hot lead-water should not be applied to a cutaneous inflammation.

Saturated watery solution of Epsom salt is of real value in inflammation. It is applied as a wet compress covered with rubber dam. It is moistened every two or three hours and renewed in twenty-four hours, the skin being washed at the time of renewal. In many cases it allays pain and abates swelling (Tucker in "Jour. Experimental Med.," May 25, 1907).

Tincture of iodin is astringent, sorbefacient, counterirritant, and antiseptic. It must not be used pure. For application to adults it should be diluted with an equal amount of alcohol, and for children with 3 parts of alcohol. In using iodin, paint it upon the part with a camel's-hair brush and fan it dry, applying one or more coats. The repeated application of iodin to the skin is of great benefit in inflammation of the glands, muscles, tendons, joints, and periosteum. Iodin is apt, after a time, to vesicate, and must not be used in full strength, because it is irritant. It is of special value in chronic inflammation. In deep-seated inflammation it acts as a counterirritant.

Nitrate of silver is a non-irritating astringent of considerable value in inflammation of mucous membranes. It forms a protective coat of coagulated albumin, and is much used in treating the throat, mouth, and genital organs. In urethral inflammation a proteid compound of silver known as

protargol may be used.

Mercurials.—Blue ointment, pure or diluted to various strengths, is extremely valuable. It is spread upon lint and kept applied over areas of fully developed inflammation. It is especially useful in acutely or chronically inflamed joints, glands, tendons, etc. Blue ointment is strongly irritant, and will soon blister or excoriate a tender skin. It is very beneficial in periostitis,

and is employed largely in chronic inflammations.

The Douche.—The douche consists of a stream of water falling upon a part from a height. The water may be poured from a receptacle or may run through a tube, and may be either hot or cold. Alternating hot and cold streams are very popular in inflammations of joints and tendons, especially in chronic inflammation. This mode of application is known as the "Scotch douche." It restores the tone of the blood-vessels and plasma-channels and promotes the absorption of inflammatory exudate. If the part is very tender, the water should be squeezed upon it from sponges. In a sprain of the kneejoint, after a time, when thickening has occurred, pour upon the part daily, from a height, first a pitcherful of very hot water, then a pitcherful of very cold water; then use friction with a hand greased with cosmolin. Hot vaginal douches are generally employed in pelvic inflammations.

Massage.—Massage is a procedure not employed frequently enough. It is very useful in some acute inflammations, though in these it must be gentle. It is of great service in the treatment of sprains of joints and fractures of bones. It is influential for good in chronic inflammations at the period when rest is abandoned. It acts by promoting the movements of tissue-fluids (blood, lymph, and areolar fluid), stimulating the absorbents, strengthening local nervous control, and thus improving nutrition. Passive motion in joints

acts as massage.

Heat.—Heat may be used continuously or intermittently, and may be either moist or dry. A considerable degree of heat will act like cold and contract the vessels. The degree necessary to cause vascular contraction would not destroy the tissue, but would produce discomfort, which discomfort would become unbearable during the continuance of the application. Therefore, heat is rarely used in the earliest stage of an acute inflammation. It is hard to state exactly when heat should be substituted for cold. Certainly when retardation and stasis are manifest it is to be preferred. Moderate heat

should be used when inflammation is not very superficial. In a cutaneous inflammation heat usually does harm, because it increases the congestion of an inflamed superficial part. In deep-seated inflammations heat to the surface acts as a revulsive or counterirritant. Thus a poultice to the chest may do good in the first stage of pneumonia, and cauterization of the skin near a joint may benefit an acute synovitis. The use of heat for purposes of counterirritation will be discussed under the head of Counterirritants. A moderate degree of heat applied over a fully developed and not too superficial inflamed area dilates the vessels, especially the veins, of the skin and superficial tissues. Thus circulation is re-established in an area filled with stagnant blood or blood which is scarcely moving and the inflamed region is drained, fluid exudate is absorbed, tension is lessened, the lymph-spaces and vessels distend, and lymphatic absorption becomes active. The application of heat increases the ameboid activity of the leukocytes, phagocytes gather in great numbers and surround an area of infection, and those which have taken up bacteria or tissue débris hurry away.\* Heat also, in all probability, causes antibodies to escape from the leukocytes and blood-serum. Heat notably lessens the pain of inflammation. It is often used purely to relieve pain.

The forms of heat are—(1) fomentations; (2) poultices; (3) water-bath; and (4) dry heat.

Fomentation is the application to the skin of a piece of flannel containing a hot liquid. A basin is warmed and over the top of the basin a towel is placed. A piece of flannel folded in two or three thicknesses is laid upon the towel and boiling water is poured upon it. By twisting the towel the water is squeezed out of the flannel. Great care must be taken to squeeze the water out of the flannel, otherwise the skin may be scalded. The hot flannel is laid upon the skin over the disordered part. A rubber dam larger than the flannel is placed over it, a mass of cotton is laid upon the rubber dam, and a bandage is applied. The fomentation must be changed within an hour unless a hot-water bag has been placed outside the bandage, in which case it need not be changed for two hours or more. The flannel which is dipped into the hot liquid is known as a "stupe." The turpentine stupe is made by wringing out the flannel as above and then putting upon it from 10 to 20 drops of turpentine. Instead of fomenting the part, steam may be thrown upon it. Fomentations are used chiefly for their reflex influence over deep congestions or inflammations. The liquid of a fomentation may, if desired, contain corrosive sublimate, carbolic acid, or other agents. A fomentation containing an antiseptic is known as an antiseptic fomentation. An antiseptic fomentation, or, as it is often called, an antiseptic poultice, is made and applied as follows: Gauze is used instead of fiannel, and is laid upon the towel over the basin as previously described. A very warm solution of corrosive sublimate (1:1000) is poured upon the gauze, the material is partly wrung out, placed upon the part, covered with a tubber dam, and upon it a hot-water bag is placed. Fomentations are very useful in relieving pain in any stage of an inflammation and act also as counterirritants. Fomentations are used in preference to ordinary poultices if there is any probability of a surgical operation becoming necessary, because skin to which a poultice has been applied cannot be satisfactorily sterilized. The antiseptic fomentation is of great service in removing sloughs from foul wounds

<sup>\*</sup> Nancrede, in "Principles of Surgery."

of poultice which is admissible when the skin

A poultice is a soft mass applied to a part to bring apon it. Poultices can be made of ground flaxseed, arrowroot, starch, bread and milk, potatoes, turnips, poultice, scald a spoon and a tin basin, put the flax-To make the sin, and pour upon it boiling water in sufficient quan-The proper consistence is found when the mass The state of the special and the special state of the special inch spon a piece of warm muslin, a free edge being left all muslin are turned in, and the flaxseed is covered prevent adhesion to the skin. The poultice should be and be covered outside with oiled silk, a rubber dam, or of cotton is applied outside of the rubber and the poulby a bandage or binder. It can be kept very warm for a by placing upon it a bag filled with hot water. If a hotapployed, a poultice should be changed every two hours. moistened with hot water, is a good substitute poultice. water and covered with some impermeable material does remented poultice, which was once popular for gangrenous by sprinkling yeast upon an ordinary cataplasm. The is made by stirring charcoal into the usual poultice-mass. about gr. ij ounce of poultice-mass may relieve pain. Flaxseed is a vegeadheres to the skin, enters the mouths of glands and follicles, and can be removed only with great difficulty. The prepaantiseptic poultice or fomentation is described above. Poultices sept on the part too long, as they will cause vesication, especially conditions. If a poultice is causing vesication, remove it and replace it, or replace it after sprinkling the part and the poultice with exid of zinc. If suppuration exists or is seriously threatened, do waste time by using poultices, but incise at once. Incision may presupperration by relieving tension, affording drainage, and permitting the antiseptics. If pus exists, it cannot be evacuated too soon. To sealtices and delay incision is often productive of irreparable harm. liter incision of a purulent focus it is common practice to apply an antiseptic locacutation in order to draw quantities of leukocytes to the part and thus limit the spread of infection and stimulate granulation.

Moderater Bath.—The continuous hot bath is now rarely employed except in burns and cases of phagedena, when it often proves curative. In these cases an antiseptic agent may be dissolved in the water. Continuous immersion in a warm bath is regarded favorably by some surgeons for the treatment of sloughing wounds and large purulent areas. The immersion of a part from time to time in water as hot as can be tolerated is useful in fully developed and in chronic inflammation. Such immersion benefits an inflamed joint, lessening the pain, swelling, and stiffness.

Dry heat is applied by a metallic object dipped in hot water and laid upon the part; by Leiter's tubes, through which hot water flows; by the hot-water bag or by the hot-air apparatus. Some surgeons use the hot-water bag in cases of mild appendicitis, in order to favor the formation of adhesions. The bet-water bag is often soothing and beneficial when laid upon an inflamed joint, or on the perineum or the hypogastric region in cystitis. A bag of hot sand, a hot brick, or a bottle or can of hot water may be used instead of the bag. The hot-air apparatus is of very great service in the treatment of chronic inflammation and particularly of inflamed joints (vide dry hot-air apparatus).

Treatment when Suppuration is Threatened.—When suppuration is threatened, ordinary hot fomentations or antiseptic fomentations must be used, and the part must be kept at rest. As previously explained, the flaxseed poultice is inadmissible. When suppuration is threatened, the use of heat causes the collection of multitudes of leukocytes, which tend to limit the area of infection and destroy bacteria. Even when suppuration is not prevented, heat aids in the rapid breaking down of the diseased tissue at the focus of the inflammation and causes hordes of leukocytes to gather and encompass the suppurating tissue, and these leukocytes prevent the spread of the infection.

In most cases, when suppuration is obviously inevitable or seriously threatened, a *free incision* will be of greatest benefit.

Irritants and Counterirritants in Inflammation.-Irritants attract an increased supply of blood to the part whereon they are applied, and are used for their local effects. Counterirritants are used to affect by reflex influence some distant part. In chronic inflammation irritants may do good by promoting the blood-supply, thus favoring the removal of exudates (liniment for rheumatism and synovitis, and nitrate of silver for ulcers). Counterirritants are powerful pain-relievers when used over an inflamed structure; they bring blood to the surface and are thought by many writers to cause anemia of internal parts, the site and area of anemia depending on the site, the area, and the duration of the surface irritation. Some recent studies seem to indicate that counterirritation produces hyperemia of the superficial part, compensatory anemia of surrounding regions, and anemic edema of the subcutaneous tissue and muscles (W. Wecksberg, "Zeit, f. klin. Med.," Bd. xxvii, H. 3 u. 4). Nancrede dissents from the statement that counterirritants cause anemia of internal parts; and he maintains that they irritate deeper parts and cause more external blood to be taken to them. He claims that a blister applied to the chest produces a hyperemic area in the pleura, and refers to Furneaux Jordan's opinion that direct irritation to the surface over a joint adds to synovial hyperemia, and that consequently in joint-inflammation counterirritants should be applied above and below a joint, but not directly over it. As a matter of fact, we know clinically that powerful counterirritation directly over an inflamed superficial joint is occasionally followed by an aggravation of the trouble, and that in pericarditis blistering directly over the pericardium may, as pointed out by Brunton, make the condition worse. Counterirritants not only relieve pain in the earlier stages of inflammation, but they also promote absorption of exudate in the later stages, and are particularly valuable in chronic inflammations. Great benefit is obtained by blistering old thickened ulcers, and by painting the chest with iodin to relieve pleuritic effusion. Frictions, besides their pressure effects, act as counterirritants. Frictions may relieve skin pain, and are associated with the application of stimulating liniments in the treatment of stiff joints. A mustard plaster is a

valuable counterirritant in an acute deeply seated inflammation. Tincture of iodin is extensively used in chronic inflammation.

There is no more efficient method of relieving pleural effusion than by the application of a succession of blisters. Blisters are also used in the treatment of inflamed joints, pericarditis, pneumonic consolidation of the lung, acute and chronic rheumatism, etc.; and are applied back of the ears or at the nape of the neck in congestive coma or meningitis. A blister can be produced in a few minutes by soaking a bit of lint in chloroform, and after applying it to the surface, covering it with oiled silk or with a watch-glass. Equal parts of lard and ammonia will blister in five minutes. It is easier to blister with cantharidal collodion or blistering paper. Before applying a blister, shave the part if it be hairy; then grease the plaster with olive oil and apply it. Blistering plaster is left in place six hours in the case of an adult, but only two hours in the case of an old person or a child; the plaster is then removed, and if a blister has not formed, the part must be poulticed for a few hours. When a blister is obtained, open it with a needle which has been dipped in boiling water. If the surgeon wishes the blister to heal, it should be covered with a piece of lint smeared with cosmolin or with zinc ointment. If it is to be kept open for a time, cut away the stratum corneum and dress with cosmolin, each ounce of which contains six drops of nitric acid.

Pustulation can be effected with tartar-emetic ointment or with Vienna paste. Tartar-emetic ointment was formerly used on the scalp in meningitis. Vienna paste consists of 5 parts of caustic potash and 6 parts of lime made into a paste with alcohol. It is applied for five minutes, and is then washed off with vinegar.

The hot iron is the most powerful of counterirritants. It is chiefly used in chronic inflammation of joints, bone, and the spinal cord. The application is, of course, very painful, and it is best to give an anesthetic before using the cautery. A flat cautery iron may be used, or the round iron. The latter is known as the button or Corrigan's cautery. The iron is used at a white heat. One area or several may be seared. The cautery is drawn lightly two or three times over each spot we wish to burn. The object is to destroy only the superficial layers of the skin. After the cauterization is completed, lint wet with iced water is applied for several hours to allay pain, and then hot antiseptic fomentations are used until the slough separates.

If we wish to prevent healing after separation of the slough, dress the sore with cosmolin, each ounce of which contains 6 drops of nitric acid. It is not wise to cauterize deeply directly over a superficial joint.

Constitutional Treatment of Inflammation.—Certain remedies are used in inflammation for their general or constitutional effects; these remedies are—(1) general bleeding; (2) arterial sedatives; (3) cathartics; (4) diaphoretics; (5) diuretics; (6) anodynes; (7) antipyretics; (8) emetics; (9) mercury and iodids; (10) stimulants; and (11) tonics.

General Bleeding, Venesection, or Phlebotomy.—Venesection is suited to the early stages of an acute inflammation in a young and robust subject. The indication for its employment is increased arterial tension, as shown by a strong, full, rapid, and incompressible pulse in a vigorous young patient. General blood-letting diminishes blood-pressure and increases the speed of the blood-current, thus amends stasis, absorbs exudate, and washes adherent

corpuscles from the vessel-wall; furthermore, it reduces the whole amount of body blood and thus forces a greater rapidity of circulation, decreases the amount of fibrin and albumin, lowers the temperature, arrests cell-proliferation, and stops effusion.

This procedure was in former days so highly esteemed that it settled into a routine formula to be applied to every condition from yellow fever to dislocation. The terrible mortality of the cholera epidemics from 1830 to 1835 led practitioners to question the belief that bleeding was a general panacea, and from this doubt there was born in the next generation violent opposition to blood-letting in any disease. Like most reactions, opposition has gone too far, the pendulum of condemnation has swung beyond the line of truth and sense, and thus is universally neglected or broadly condemned a powerful and valuable resource. Many physicians of long experience have never seen a person bled; its performance is not demonstrated in most schools, and but few patients and families will permit it to be done. But when properly used it is occasionally beneficial. It is applicable, however, only to the young, strong, and robust, and not to the old, weak, or feeble. It is used for violent acute inflammations of important organs or tissues, and not for low inflammations or for slight affections of unimportant parts. It is used in the early, but not in the late, stages of an inflammation. It is used when the pulse is frequent, full, hard, and incompressible, but not when it is slow, small, soft, compressible, and irregular. It is used when the face is flushed, but not when it is pallid. It is not used in fat persons, drunkards, very nervous people, or the sufferers from adynamic, septic, or epidemic diseases. It is of value in some few cases of congestion of the lungs, pneumonitis, pleuritis, meningitis, prostatitis, cystitis, and other acute inflammatory conditions. It is particularly valuable when uremia exists or when there is distention of the right side of the heart. The method of bleeding is described on page 463.

After bleeding, the patient should be put on arterial sedatives, diuretics, diaphoretics, anodynes, and, if necessary, purgatives. A favorite mixture of Prof. S. D. Gross was the antimonial and saline, gr. xl of Epsom salt, gr.  $\frac{1}{10}$  of tartar emetic, 2 drops of tincture of aconite, and 3j of sweet spirits of niter, in enough ginger syrup and water to make  $\frac{2}{3}$ ss; given every four hours.

Arterial Sedatives.—Drugs of this character are of great use before stasis is pronounced; but if used after stasis is established they will increase it. If stasis exists it may be relieved by blood-letting, local or general, and then arterial sedatives can be given. Either local bleeding or venesection abolishes stasis and lowers tension, and arterial sedatives maintain the effect and hold the ground which is gained. The arterial sedatives employed are aconite, veratrum viride, gelsemium, and tartar emetic. These sedatives lessen the force and the frequency of the heart-beats, and thus slow and soften the pulse, and are suited to a robust person with an acute inflammation, but are not suited to a weak individual in an adynamic state.

Aronite is given in small doses, never in large amounts. One drop of the tincture in a little water is given every half hour until its effect is manifest on the pulse, when it may be given every two or three hours. Large doses of aconite produce pronounced depression, and are dangerous. Aconite linears the temperature, slows the pulse, and produces diaphoresis.

Veratrum viride is a powerful agent to slow the pulse and to lower blood-

pressure; it produces moisture of the skin, and often nausea. It is given in 1-drop doses of the tincture every half hour until its physiological effects are manifested, when the period between doses is extended to two or three hours. Ten drops of laudanum given a quarter of an hour before each dose of veratrum viride will prevent nausea.

Gelsemium is an arterial sedative highly approved by Bartholow. It is given in doses of 5 to 10 drops of the tincture every three or four hours.

Tartar emetic lowers arterial tension and lessens the pulse-rate. This drug is not generally employed; if it is used with the greatest care it is no better than some other agents, and if it is not so used it will cause dangerous depression. The dose is from gr.  $\frac{1}{20}$  to gr.  $\frac{1}{10}$  in water every three hours until the physiological effects are manifest.

Cathartics.—Purgation is of great value in inflammation. By it putrid material is removed from the intestine, fluid containing poisonous elements is drawn from the blood, and the liability to infection of the tissues is lessened. The administration of purgatives is, of course, not to be a routine procedure in inflammatory states. The bowels may be acting so freely that no cathartic is required. Treatment in an inflammation should be inaugurated, if constipation exists, by giving a cathartic. The tongue affords important indications as to the necessity for purgation. Castor oil can be given in capsules, or in the froth of beer, or the juice of half a lemon is squeezed into a tumbler, I ounce of oil poured in, and the rest of the lemon is squeezed on top, thus making a not unpalatable mixture. Aloin, podophyllum, the salines, and calomel in 5- or 10-grain doses, followed by a saline, have their advocates. In beginning peritonitis the salines are used by many surgeons, a teaspoonful of Epsom salt and a teaspoonful of Rochelle salt being given hourly until a movement occurs. In the course of inflammation, from time to time, if there be constipation, a coated tongue, and foulness of the breath, there should be ordered gr. j of calomel with gr. xxiv of bicarbonate of sodium, made into twelve powders, one being given every hour; if the bowels are not moved by the time the powders are all taken, a saline should be given. If a violent purgative effect is desired, as in meningitis, croton oil or elaterium may be ordered. If constipation is persistent, give fluidextract of cascara sagrada daily (20 to 40 drops), or a pill at night containing gr. 1 of extract of belladonna, gr. 1 of extract of nux vomica, gr. 10 of aloïn, gr. 1 of extract of physostigma, and gtt. of oil of cajuput. Enemas or clysters may be used in some cases. A very useful enema is composed of f3j of oil of turpentine, f3iss of olive oil, f3ss of mucilage of acacia, in 15x of water. Soapsuds and vinegar in equal parts make a serviceable clyster. A combination of oil of turpentine, castor oil, the yolk of an egg, and water can be used. Asafetida, gr. xxx to the yolk of one egg, makes a good enema to amend flatulence.

Diaphoretics.—These agents are very useful. A profuse sweat removes much toxic material from the blood and in the beginning of an acute inflammation, such as tonsillitis, may abort the disease. Dover's powder is commonly used, but pilocarpin is preferred by some. Camphor in doses of from 5 to 10 grains is diaphoretic, and so are antimony and ipecac. Acetate and citrate of ammonium, opium, alcohol, hot drinks, heat to the surface (baths, hot bricks, hot-water bags), serpentaria, and guaiac are diaphoretic agents.

Diuretics.-Diuretics are useful in fevers when the urine is scanty and

high-colored, and are valuable aids in removing serous effusions and other exudates. Among the diuretics may be mentioned calomel in repeated large doses, cocain, alcohol, digitalis, the nitrites, squill, turpentine, copaiba, and cantharides. The liquor potassæ and the acetate of potassium are the best agents to increase the solids in the urine. The liquor potassii citratis in doses of f5j to f5iv is efficient. Large draughts of water wash out the kidneys. If the heart is weak, citrate of caffein is a good stimulant diuretic, and hot coffee is very serviceable in promoting the secretion of urine. The injection of hot salt solution into the rectum and under the skin favors diuresis, and the intravenous infusion of salt solution is a very powerful diuretic (see page 465). The application of heat to the loins promotes the secretion of urine. Sodiotheobromin salicylate (diuretin) is an uncertain but often valuable diuretic, in doses of gr. x every two or three hours.

Anodynes and Hypnotics.—Drugs may be required to allay pain or procure sleep. Dover's powder, besides being diaphoretic, is anodyne. Opium acts well after bleeding or purgation. If it causes nausea, it should be preceded one hour by the administration of gr. xxx of bromid of potassium. Opium is used by the mouth, by the rectum, or hypodermatically. It is used when there is pain, but its use is not to be long persisted in if it can be avoided. It is given in doses measured purely by the necessities of the case. If opium disagrees, try the combination of morphin with atropin. After an operation antipyrin or phenacetin will often quiet pain and secure sleep. When a person feels "so tired he can't sleep," alcohol in the form of whiskey or brandy must be given. Sleeplessness not due to pain is met by chloral, trional, the bromids, or sulphonal. Chloral is dangerous in conditions of weak heart or exhaustion. Bromids must be given in large doses to be efficient. Sulphonal must be given about four or five hours before sleep is expected, in doses of from gr. x to gr. xx in hot milk or hot mint-water. Trional is safe and very satisfactory. It is

given in doses of gr. xv to gr. xxv in hot water.

Antipyretics.-Arterial sedatives, diaphoretics, and purgatives lower temperature, and have previously been alluded to (page 100). There are two great classes of febrifuges-those which lessen heat-production and those which increase heat-elimination. In the first group we find quinin, salicylic acid and the salicylates, kairin, alcohol, antimony, aconite, digitalis, cupping, and bleeding. In the second group we find alcohol, nitrous ether, antipyrin, acetanilid, phenacetin, opium, ipecac, cold to the surface, and cold drinks. In surgical inflammations it is rarely necessary to employ heroic means to lower temperature. The use of such an agent as antipyrin is contraindicated in the weak and adynamic, and it is never to be thought of as a means of lowering temperature unless the latter goes above 103° F. Quinin, in doses of EL xx to gr. xxx given at 4 P. M., may prevent an evening rise; salol or salicin can be given during the day. Inunctions of 30 minims of guaiacol lower the temperature in tuberculous conditions and in septic fevers. These inunctions are made upon the abdomen, and often produce surprising results. Dujardin-Besumetz maintained that fever is a condition in which the animal organism is endeavoring to oxidize and render inert certain poisonous material, and that antipyretic drugs lessen oxidation and actually make the patient worse. This view is in accordance with the experience of a number of surgeons. It is a suggestive fact that bacteria are said to multiply more rapidly when kept

at about the normal body temperature than when kept at fever heat (102° F., or more). The mere discomfort of fever may be much mitigated by anti-

pyretic drugs, but the fever process is not benefited by them.

Emetics.—Emetics may do good when the patient suffers from a parched, coated tongue, a dry and hot skin, nausea, and gastric oppression, but it is very rarely in these days that we employ them. There can be used 5j of alum in molasses, gr. xx of sulphate of zinc, or a tablespoonful of mustard and a teaspoonful of salt given in warm water and followed by large draughts of warm water. Ipecac in a dose of gr. xx can be employed. The emetic dose of tartar emetic is gr. ij, but it is too depressant a drug to trifle with. The sulphuret of antimony in doses of from 1 to 5 grains is safe. Apomorphin hypodermatically, in a dose of from gr.  $\frac{1}{16}$  to gr.  $\frac{1}{8}$ , will act in five minutes. Emetics are valuable in inflammatory conditions of the air-passages, but their use is contraindicated in diseases of the heart, brain, and bowels, in hernia, in dislocations, in fractures, and in aneurysms.

Mercury and the Iodids.-Mercury is an alterative-that is, an agent which favorably affects body nutrition without causing any recognizable change in the fluids or the solids of the body. Mercury lessens blood plasticity, hinders the exudation of liquor sanguinis-thus furnishing less food to the cells in the perivascular tissues-and retards cell-proliferation. Further, by a stimulant action on the absorbents it promotes the breaking up of an existing inflammatory exudation, and hence limits damage from excess of new formation. The time at which mercury is best given is when violent symptoms have abated, the guides being a reduced temperature and a moist skin. Mercury is often given in conjunction with the local use of sorbefacients (ichthyol, or mercurial ointment). When possible, the administration of mercury is associated with compression of the inflamed part. It is sometimes given until the gums are slightly touched, but it is not given to the point of salivation. When the breath becomes offensive and the gums tender on snapping the teeth, or when griping and diarrhea begin, the dose should be reduced, or the drug should be stopped (see Ptyalism). In iritis mercury is used to get rid of the plastic effusion which is causing pupillary fixation and opacity. In keratitis the gums should be touched slightly. In orchitis, after the subsidence of the acute symptoms, mercury should be employed. In pericarditis, meningitis, and in many chronic and lingering, and in all syphilitic inflammations, this drug can be used.

Some persons will be salivated with very minute doses of mercury, either because of idiosyncrasy or previous saturation. Others can take enormous doses without any appreciable constitutional effect. The action of mercurials can be favored by a combination with ipecac or with tartar emetic.

In giving mercury, if a prompt effect is desired, give gr. iij of calomel every three hours until a metallic taste is noted in the mouth. If the case is not so urgent, gray powder is a good combination. Children are given calomel and sugar or mercury and chalk. If it is desired to give the drug for some time, corrosive sublimate is a suitable form, and small doses will actually increase the number of red blood-corpuscles. Corrosive sublimate is to be given alone or combined only with iodid of potassium. The green iodid of mercury is a drug suitable for prolonged administration. In the prolonged use of mercury it will often be necessary to give at the same time a little opium to prevent

diarrhea and griping. A rapid effect can be obtained by rubbing daily with a gloved hand 5j of the oleate of mercury or 5ss of the ointment into the groins, the axillæ, or the inside of the thighs. Suppositories of mercurial ointment induce rapid ptyalism. Hypodermatic injections of corrosive sublimate or gray oil may be used, and must be thrown deeply into the muscles of the buttock or back. Old people, those who are exhausted, anemic, and broken down, and the tuberculous bear mercury badly. If it be given to them at all, it must only be in small amounts and for a brief time.

Alkaline iodids are useful in removing the products of inflammation; they can be given for a long time, and admirably supplement mercurials. Iodid of potassium can be prescribed in combination with corrosive sublimate as follows:

Iodid of potassium, well diluted, is given on a full stomach; it is never given concentrated or before meals. A convenient mode of administration is to procure a concentrated solution of the iodid of potassium, remembering that every drop equals about gr. j of the drug, and give as many drops as may be desired in half a glass of water after meals. If the medicine disagrees, add to each dose, after it is put in water, 3j of the aromatic spirit of ammonia. Extract of licorice is a good vehicle for the iodid. If the mixture in water disagrees, the drug should be given in milk. Capsules are satisfactory, but a drink of water should be taken just before and again just after taking a capsule, to protect the stomach from the concentrated drug. Iodid of sodium may agree when iodid of potassium does not. When the iodids disagree they produce iodism. The first indications of iodism are a bad taste in the mouth, running of the eyes and nose, and sneezing, followed by a feeling of exhaustion, absolute loss of appetite, nausea, tremor, and skin eruptions (acne, hemorrhages, blebs, hydroa, etc.). If iodism occurs, stop the drug and give the patient Fowler's solution in increasing doses, laxatives, diuretic waters, and also nutritious food, and stimulants if depression is great. Sometimes belladonna does good in obstinate cutaneous disorders induced by the iodids.

Remedies Directed Against Special Morbid States.—If inflammation is associated with rheumatism, gout, scurvy, syphilis, tuberculosis, or any other constitutional disease or predisposition, appropriate treatment should be instituted to control the disease or combat the predisposition, and at the same time the area of inflammation should be locally treated. Syphilis is treated by the internal use of mercury; in some cases the iodids are also given; scurvy, by regetable juices and potash salts; rheumatism, by the alkalies or salicylates; gout, by colchicum or piperazin; tuberculosis, by the fats, tonics, and open-air life.

Stimulants.—The chief stimulants used are hot black coffee by the stomach or bowel; hot normal salt solution by the bowel, beneath the skin, or in a vein, alcohol by the mouth or rectum; and strychnin or atropin hypodermatically. The use of alcoholic stimulants is called for by conditions rather than by diseases, being indicated by the state of the patient rather than by the name of the malady. For a brief acute inflammation in a robust young person alcohol is not needed; but all who are weak or exhausted, be they

young or old, all who are aged, those who are accustomed to alcoholic beverages, those who have high temperatures or failure of circulation, and those who labor under septic inflammations or adynamic processes require alcohol, and it should be given with a free hand. In an acute malady, a feeble, compressible, rapid, or irregular pulse, and great weakness of the first sound of the heart are indications that alcohol is required. Low, muttering delirium is a strong indication for stimulation. There is no dose of alcohol for these states; it is given for its effect. Two ounces of brandy or whiskey may be needed in a day, or perhaps 20 ounces. If the breath of the patient smells strongly of the alcohol, he is getting too much. If delirium increases after each dose, alcohol is doing harm. Alcohol is contraindicated in acute meningitis. In acute illness use whiskey, brandy, champagne, or alcohol and water. During convalescence there may be used a little port, claret, or sherry wine, or malt liquor. These agents will promote appetite, digestion, and sleep.

Strychnin is a very valuable stimulant. It can be given in doses of  $\frac{1}{30}$  to  $\frac{1}{20}$  gr. three times a day, but after a few days seems to lose its stimulant effect.

Atropin is one of the best remedies for exhaustion of the vasomotor sys-

tem. The dose is gr.  $\frac{1}{100}$  hypodermatically.

Tonics.—The use of tonics is indicated during convalescence from acute and throughout the course of chronic inflammations. There may be used iron, quinin, and strychnin in the form of elixir; iron alone, as in the tincture of the chlorid; quinin in tonic doses (gr. vj to gr. viij daily); or Fowler's solution of arsenic. An excellent pill consists of—

R.	Acid. arsenos.,	gr. j;
180	Strychnini,	gr. SS;
	Quinini,	
	Ferri redact.,	gr. vj.—M.
	in pil. No. xxiv.	
Sig.	—One after each meal.	

Bitter tonics before meals improve the appetite. One of the best of tonics is tincture of nux vomica in gradually increasing doses.

Antiphlogistic Regimen.—This term comprises the necessary directions

relating to diet, ventilation, cleanliness, etc.

Diet .- When, in the early stages of an acute inflammation, the patient cannot eat, there must be administered a cathartic before food is given. Nausea is combated with calomel and soda, drop-doses of a 6 per cent. solution of cocain, iced champagne, iced brandy, chloroform-water, hot water, cracked ice, and counterirritation of the epigastric region. When the process is depressive from the start, and in any case after the earliest stage, feeding is of vital moment. The great tissue-waste calls for large quantities of nutritive material, but the impaired digestion demands that the food shall be easily assimilable; hence it is taken in liquid form, small quantities being frequently given. Albumin-water is an agreeable beverage of some nutritive value. Milk contains all the elements required by the body, and is the food of foods. If it disagrees, it should be mixed with lime-water, or to each dose an equal amount of Vichy or soda-water may be added. Peptonized milk is a valuable agent. Some people can take boiled milk who cannot take cold unboiled milk. Some patients, however, digest raw better than boiled milk. Peptonized milk has been to a great extent superseded by pancreatized milk. It is given cold, either alone or mixed with a carbonated water. Koumiss is retained in some cases when the stomach rejects all other foods. This fermented milk is nutritious, stimulant, and very useful. One part of milk, 2 parts of cream, and 2 parts of lime-water make a nutritious and digestible mixture. Milk punch is largely used. Whey may be used when plain milk cannot be taken. Eggs are highly nutritious, but are apt to disturb the stomach; they may be given as egg-nog, or simply soft-boiled, or the yolk can be beaten up in a cup of tea, or raw eggs may be given in sherry or brandy. When considerable nausea exists the yolk of an egg may be added to 3j of lemon-juice and 3ij of sugar, the glass being filled with carbonated water. Beef-tea is certainly a stimulant, but it is not a food. It contains the excrementitious elements of the beef. It is prepared by cutting up one pound of lean beef, adding to it a quart of water, and then simmering, but not boiling, down to a pint, finally filtering and skimming the liquid. The dose is a wineglassful seasoned to taste. Beef juice is nutritious. It is prepared as follows: A thick and tender beefsteak is partly broiled over a hot fire, the outside is browned and the juice is retained within the meat. The steak is cut into pieces to fit a lemon squeezer or meat press (the instrument having been warmed by previously dipping it in hot water). The juice is expressed by squeezing and may be given warm, seasoned with salt and pepper, or may be taken after it has been frozen. Fresh meat juice may be used plain or pancreatized. The meat juices obtained in the shops have little nutritive value. Bouillon and beef extracts have slight nutritive value. Meat jellies (calf's foot being the one commonly used) have a certain though small nutritive value by producing a certain amount of energy which, were they not given, would of necessity be furnished by protein. Hence, meat jelly sives or spares protein (Bauer). Clam-juice and clam-broth are palatable and slightly nutritious. They are retained in many cases when any other food would be rejected. The broth is to be given hot and the juice either hot or cold. Coffee is a valuable stimulant in febrile conditions. When the stomach entirely rejects food day after day, nutritive enemata are given. There is dispute as to their value because it is certain that the large intestine does not digest by juices of its own manufacture. It seems equally certain, however, that it does absorb water as part of its physiologic duty and that it can absorb alcohol, saline fluid, grape-sugar, certain drugs, and digested albumin and fat. Undigested albumin and fat should never be given by enema. These materials should be pancreatized before injection or should be mixed with pancreas and then injected, the peptones being formed in the bowel. Nutritive enemata are given at a temperature of 90°-95° F. They should not be bulky (not over 7 or 8 ounces), because a large enema is usually quickly expelled. They should not be given oftener than three or perhaps four times a day because too frequent administration irritates the rectum and enemas will not be retained by an irritated rectum. During the period that rectal enemata constitute the method of feeding, the rectum should be washed out once a day by a high enema of warm salt solution; this cleansing enema is given one bour before a nutritive enema. A useful enema is Leube's meat and pancreas-3 ounces of pancreas and 8 ounces of meat are rubbed together by a postle, tepid water is added, and the mixture is injected. It undergoes digesfion in the large bowel. Bidwell's formula is as follows: Two ounces of milk,

2 ounces of strong beef-tea, yolk of 1 egg, 1 dram of pancreatic solution, prepared one hour before using and kept during the interim at a temperature of 100° F. Brandy can be added just before using. Enemata of salt solution greatly relieves thirst. When the sufferer feels able to eat a little, any good soup, strained and skimmed, should be ordered. As the patient gets better he may be fed on scraped meat, broth containing crumbs, tapioca with cream, custard, milk-toast, sweetbreads, chops, oysters, chicken, etc., until he gradually reaches ordinary diet.

The temperature should be taken at regular intervals, and the condition of the gastro-intestinal tract should be observed. The urine must be examined at intervals, and the daily amount passed must be known. If insufficient urine is being passed, increase the amount of fluid, particularly of water, given by the mouth. If the urine is scanty and the patient is nauseated by drinking water, give enemata of hot saline fluid or employ hypodermoclysis. The pulse and heart must be frequently observed, and cardiac weakness must be

combated by suitable stimulants.

Ventilation and Cleanliness.—The ventilation of the apartment is of the greatest importance. Every day the windows should be opened widely for a time, the patient, of course, being protected from chilling and kept out of a draft. When the windows are open the air of a room can be quickly changed by swinging the door to and fro. A constant access of fresh air must be secured, and the temperature kept as near as possible to 68° F. If high fever exists, the sick man must be cleaned and be sponged off with alcohol and water every day. It is important that the bed-clothing be clean and that the sheet be unwrinkled, as otherwise bed-sores may form.

Treatment of Chronic Inflammation.—The subject of chronic inflammation has been referred to previously. The local treatment comprises rest, relaxation, elevation, counterirritation, massage, passive movements, the douche, the application of sorbefacients, the use of compression, incision, and, perhaps, certain special methods, as the induction of passive hyperemia by Bier's method or baking the part in a hot-air oven. The patient must be placed under proper hygienic and climatic conditions; the diet must be judiciously regulated; drugs are given symptomatically or to combat some constitutional tendency or disease (see articles upon Special Regions and

Diseases).

Bier's Hyperemic Treatment of Inflammation.—(See Bier's Hyperemic Treatment, by Dr. Willy Meyer and Prof. Dr. Victor Schmieden.) Bier believes that hyperemia in inflammation is a reaction on the part of the organism; that it is nature's effort to remove an irritant and to supply increased nutritive material, hence that it is desirable and should not be combated by cold, but should be favored by every means in our power. Bier endeavors to increase the hyperemia, which he regards as beneficial, and to combat stasis, which he is certain is harmful. By the method of treatment recommended by Bier the surgeon induces venous hyperemia by means of an elastic band or a cupping glass, or arterial hyperemia by means of hot air.

Obstructive Hyperemia by Means of the Elastic Bandage.—The constrictor should be the soft broad bandage of an Esmarch apparatus. Fig. 55 shows it applied around the arm. The bandage must not be so tight as to cut off the pulse at the wrist or to cause unpleasant sensations,

pain, or very rapid distention of the subcutaneous veins (Meyer and Schmieden). The part below the band should become bluish-red and warm, but never white under the influence of the constriction. When the bandage is in place an area of inflammation shows an increase of redness, heat and swelling, and a diminution of pain. In chronic conditions the bandage is usually employed daily and for two or three or four hours at a séance. When used for three hours or longer temporary edema may arise. In acute cases it is used for



Fig. 55.—Shows elastic bandage in place around the arm, its ends tied with tapes which are attached to the bandage. This is the style of bandage usually found upon the market. If the bandage is to remain on for a number of hours, it is advisable to apply a strip of adhesive plaster, to guard against the tapes becoming undone. Note the engorgement of the sub-transous veins of the forearm showing the effect it is desired to produce by the bandage Meyer and Schmieden).

twelve, fifteen, or twenty hours a day. Prolonged application may make the skin sore unless a flannel bandage is applied before the band is used, unless the site of application is shifted daily, and unless the skin during each intermission is well rubbed with alcohol. The bandage is always applied well above the inflamed region and that region is exposed free from dressings in order that its condition during treatment may be observed. If edema occurs the band must be removed. If the inflammation is accompanied by marked edema, incisions are required. If an abscess forms it must, of course, be opened.

Obstructive Hyperemia by Means of the Cupping Glass.—Endeavor to make the skin bluish-red but not white. Cupping glasses are used not only to treat areas of inflammation, but to aid in emptying sinuses and abscesses which have ruptured or have been incised. Figs. 56-59 show cupping glasses.



Fig. 56.—The simplest form of suction glass. The rubber bulb is attached directly to the glass. This glass is used in the treatment of furuncles of smaller size and sinuses (Meyer and Schmieden).



Fig. 57.—Illustrating an ordinary suction apparatus for the finger (felon, etc.) with a convexity at the lower surface, designed to receive the pus (Meyer and Schmieden).



Fig. 58.—Shows glass of simpler configuration; a rubber tube connects glass with bulb; the same can be readily detached, thus rendering easy the sterilization of the glass by boiling. In the tube a three-way stop-cock is inserted. This cup is used for treating furuncles of larger dimensions, etc. (Meyer and Schmieden).

I am satisfied from personal experience that Bier's method of treatment is of great value in acute inflammation as well as in chronic inflammation and that it is not used as often as it should be. Bier claims that arterial hyperemia induced by hot air is particularly useful in chronic inflammation, as it favors the absorption of exudates and of adhesions. Venous hyperemia produced by the elastic band or the cupping glass is claimed to be of great value in infections. Bier asserts that it may abolish the infection, prevent suppuration, and hasten the process to a conclusion. It does certainly lessen pain and favor absorption. The elastic band may be used upon an extremity, a testicle, the scrotum, and the head. In other regions cupping glasses are used, a partial vacuum being established in the glass by means of a pump or a rubber bulb.



Fig. 59.—Constructed for the treatment of the hand. A soft-rubber band wound around the cuff makes it fit air-tight around the arm (Meyer and Schmieden).

Sir Almroth Wright's Views Upon Inflammation and its Treatment.—Wright maintains that a free supply of blood and lymph is necessary for repair, that both the blood and lymph should contain a sufficiency of protective materials, and that it is essential that numerous active leucocytes enter the area of disease.

When there is a large serous effusion and few leucocytes, a condition met with often in tuberculous pleurisy, repair does not take place.

In abscess the leucocytes are dead and the material obtained from dead leucocytes retards healing. If the fluid exudate does not contain protective material the process extends.

Repair is retarded by induration, or by the formation of a fistula or a sinus.

If there is a small amount of fluid exudate there is little protective substance thrown into the inflamed part and repair is retarded.

If there be a large effusion and few leucocytes, cure is favored by removing the fluid. This is done in abscess and in serous effusion. If there is too little lymph in the part salt solution and citric acid should be used locally, and citric acid should be administered internally. The administration of proper bacterial vaccines will increase the protective qualities of the lymph. (See Wright's "The Pathology of Inflammation" and the resumé of his views in "Progressive Medicine," Sept. 1, 1908, p. 31).

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## IV. REPAIR.

WHEN a tissue is damaged, it reacts to the injury and Nature attempts to effect repair. It is held by many that inflammation is a destructive process and repair is a constructive process; that repair is constantly effected in an aseptic wound without many of the evidences of inflammation; that repair does not proceed from inflammation, but is retarded or prevented if inflammation occurs. As before stated, we agree with Adami, that inflammation is reaction to injury and the effort of Nature to repair the injury. As Adami points out, the attempt to repair may fail, the reaction to injury being excessive or not powerful enough; but even should the attempt fail, the conservative intention exists. "What is the development of cicatricial tissue but an attempt at repair? What other meaning can be ascribed to the increased bactericidal power of the inflammatory exudate as compared with that of ordinary lymph and blood-serum? Why do leukocytes accumulate in a region of injury? Why do some of them incorporate bacteria and irritant particles, and others bring about the destruction of these without necessarily ingesting them? All these are means whereby irritants are antagonized or removed, and reparation and return to the normal sought after." \*

Repair is favored by good general health, asepsis of the wound, coaptation of wound edges, and rest. It is retarded or prevented by infection, gaping of the wound, frequent or forcible motion, and impairment of the general health.

Albuminuria and diabetes particularly obstruct repair. R. T. Morris points out that sugar in the blood is hygroscopic, removes water from the tissues, and thus obstructs repair; and also that the wound fluids contain

sugar and are good culture-media ("Med. News," June 29, 1901).

Healing by First Intention.—A wound may heal by "first intention." This mode of healing, which is known as "primary union," occurs without suppuration, and is observed in the healing of an aseptic wound. If infection occurs, primary union will not take place. The phrase "by first intention" comes down to us from the past. It was properly thought that Nature intends to repair a wound, and first intention signifies the first or most desirable way to be wished for. In a small aseptic incision, in which no considerable vessels are cut, repair will take place very rapidly after the edges have been approximated and the wound dressed. In fact, the wound edges may be firmly held together in twenty-four hours. In such a wound a small amount of blood flows from the capillaries between the edges of the wound. and this blood clots. A trivial amount of exudation and some few migrated corpuscles pass into the clot and into the tissues. The fixed connective-tissue cells and the endothelial cells of the vessels multiply, and form epithelioid cells, known as fibroblasts. The fibroblasts eat up many of the leukocytes and multiply, so that the new cells from one side of the wound finally interlace with the new cells from the other side. Nearby capillaries become irregular in outline; at certain points bulging occurs, and at these points new capillaries develop, extend into the mass of fibroblasts, and join new capillaries of the opposite side. The reparative material is now said to be organized; it has

<sup>\*</sup> Adami, in Allbutt's "System of Medicine."

become granulation tissue. The fibroblasts become spindle-shaped and develop into interlacing fibers (Fig. 6o). The tissue is now fibrous tissue; it contracts strongly, and finally most of the capillaries are obliterated by pressure. In such a slight wound the reaction to injury is chiefly noted in the cells of the part, and the vessels and leukocytes play but a small part in repair. The exudation is so scanty that there is practically no swelling unless some arises from venous obstruction. The vessels are so slightly affected that there is no redness. The final step in healing is contraction of the fibrous tissue and the covering of the surface with epithelium, which springs from the epithelial cells upon the edges. This final process is called "cicatrization," and con-

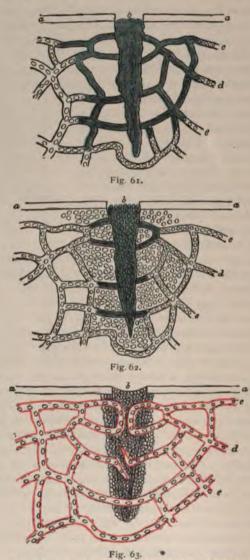
sists in the formation from fibroblasts of new fibrous tissue and the contraction of the new tissue. The "immediate union" of some writers never occurs. This term means the union of microscopical parts to their counterparts without any effort at repair. A first union is effected always by clotted blood and coagulated exudate, next by proliferating cells, and finally by fibrous tissue. A wound healing by first intention exhibits no evidence of inflammation. There is some slight tenderness, but



Fig. 60.—Cells developing into fibers (Bennett).

no actual pain. A certain amount of swelling arises because of exudation of fluid from the blood, and the coagulation of this fluid makes the wound edges hard. Venous obstruction leads in some cases to a considerable fluid swelling. A wound may heal by first intention even if some bacteria are present, if the part has a good blood-supply and the patient is in good health. Active leukocytes and germicidal blood-serum may prevent infection. In a more extensive incised wound many vessels are cut. After oozing ceases the vessels are closed by clots continuous with the clot between the sides of the wound. An exudation of plasma from the blood-vessels and of lymph from the lymph-spaces takes place. Leukocytes in great numbers invade the wound edges and the exudate, and the exudate clots. Thus, an infection may be surrounded and limited. This mass of blood-clot, plasma-clot, and leukocytes used to be known as "coagulable lymph." The leukocytes actively eat up the clot, and by the end of the third day occupy the space formerly occupied by the clot. The fixed connective-tissue cells and endothelial cells multiply and grow into the mass of leukocytes, eating up many of the leukoone, and finally join the fibroblasts of the other side of the wound. Some eukocytes enter into the lymph-spaces. New capillaries form from the capilbries at the wound margins. By the end of the first week the fibroblasts begin to assume various outlines, sending out poles or branches or becoming sindle-shaped. These spindle-shaped cells become fibers, and the fibers of the new tissue interlace and strongly contract. Thus the edges are pulled firmly together. Finally new epithelium derived from epithelium at the edges forms and grows over the wound (Figs. 61-63), and exhibits the stages of repair in healing by first intention. In order to obtain primary union the segeon must cleanse the wound and must be thoroughly aseptic; bleeding must be carefully arrested; the parts are accurately coaptated by sutures; septic or antiseptic dressings are applied, and special care is taken to secure In a large wound special methods to secure drainage are required. In

a small wound drainage is obtained between the stitches. The use of irritant germicides in a wound greatly increases the amount of discharge and renders drainage necessary in even a comparatively small wound for the first twenty-



Figs. 61-63.—Healing by first intention (after Pick): a, Skin; b, fibroblasts; c, d, e, capillaries. Fig. 61, Clot in the vessels continuous with clot between the edges of the wound. Fig. 62, Migration of leukocytes into the perivascular tissues and into the clot between the edges of the wound. Fig. 63, Formation of new capillaries.

four hours. During the first twenty-four hours after a large wound begins to heal by first intention the discharge of bloody serum is most plentiful, but after this period it becomes very scanty and soon ceases entirely, and can be much diminished in quantity in the first day by the application of pressure. Warren says that after a hip-joint amputation over a pint of bloody serum flows out during the first twenty-four hours. In an aseptic wound, as a rule, one-half of the stitches are removed on the sixth or seventh day and the remainder on the eighth day, but for two weeks more the wound should be rested and supported, as the new tissue is not very resistant to infection. Aseptic fever always arises when much exudation is poured out and not quickly and perfectly drained. Aseptic fever is due to the absorption of aseptic pyrogenous material (page 134). If an incised wound becomes infected, the pyogenic organisms destroy the bond of union which is forming between the wound edges by liquefying the intercellular substance. As a consequence, the wound edges are widely separated by pus.

What used to be known as "healing by blood-clot" is healing by first intention. If there is a considerable gap between the edges of an aseptic wound, and the gap is filled with a blood-clot, healing goes on in the same manner as when the gap is narrow, although more corpuscles, more exudate, and more

fibroblasts are required to effect repair.

Healing by Second Intention.—Healing of a wound in which there is a large cavity in the tissue or in which the edges have gaped apart is known as healing by granulation, or healing by "second intention." It is called healing by granulation because the granulations (areas of vascularized embryonic tissue) are visible. It is effected in the same manner as healing by "first intention," the processes in the two cases being practically identical if pus is absent. As a matter of fact, in healing by granulation there is usually wound infection. As a result of infection intercellular substance is peptonized, many reparative cells are cast off, and repair can be effected only after the formation of enormous numbers of fibroblasts and the expenditure of considerable time. It requires much longer for an infected wound to heal than for an incised wound to be repaired, and an infected wound can heal only by granulation. A short time after the infliction of a wound the oozing ceases because thrombi form in the vessels and some clot gathers in tissue-gaps and interstices. Exudation begins and leukocytes migrate into the exudate and into the walls of the wound. In an hour or two the surface of the wound becomes distinctly glazed or glistening, because of the formation and coagulation of fibrin. The exudation is at first thin and red, and it becomes so profuse as to wash away the discolored fibrin coat. In a few days the discharge usually becomes purulent. The connective-tissue cells, especially the endothelial cells of the vessels, proliferate and form fibroblasts, and the fibroblasts multiply to close the wound. From adjacent capillaries new capillaries form. This formation takes place as follows: A portion of a capillary thickens and a whip-like process comes off from the thickened part. This process fuses with a second filament budded from another or from the same capillary, or runs straight out as a terminal vessel. The flaments after a time are hollowed out from within, protoplasmic tubes are firmed, and endothelial cells develop from the protoplasm. In some cases a tabular prolongation comes off from a capillary directly. Figs. 63 and 64 show the formation of a capillary. In a wound healing by granulation these newlyformed capillaries run among the fibroblasts, and some of them run perpendicularly to the surface, or a loop forms and reaches the surface. The surface af a granulating wound is covered with migrated leukocytes, and directly under these are fibroblasts covering the new vascular strings or loops. Vascular strings or loops coated with fibroblasts are called granulations (Fig. 66 shows a granulating surface). When the discharge becomes purulent, many leukocytes and fibroblasts are destroyed, inflammation increases, exudation becomes profuse, and cellular multiplication widespread and rapid in order to

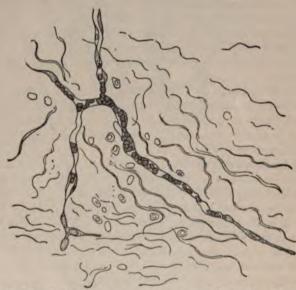


Fig. 64.-Development of a blood-vessel in mesentery of an embryo (Warren).

make up for the cells lost by microbic action. Gradually the gap is filled. As it is being filled the older fibroblasts in the deeper layers of the edges and base of the wound are converted into *cicatricial*, *fibrous*, or *scar tissue*. (Fig. 65.) As the granulations rise to a higher level at the surface the area of fibrous tissue

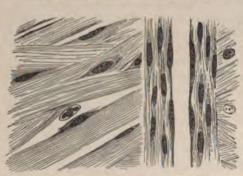


Fig. 65.-Cicatricial tissue; X 670 (Fowler).

becomes broader at the base and margins, and this young fibrous tissue contracts. By contracting it draws the edges of the wound nearer together and thus lessens the area of the surface which must be covered with epithelium. When the granulations reach the level of the cutaneous surface the epithelial cells at the margin of the wound proliferate, and young epithelial cells, constituting a bluish or opalescent film, grow

over the granulations. Epithelium comes only from epithelium. Granulations are never converted into epithelium. The epithelial covering comes only from the epithelium at the wound margins, unless there be epithelial remains

in the wound; for instance, an undestroyed papilla, sweat-duct, or hair follicle. The process of covering the surface with epithelium is known as *epidermization*. The epidermization of a large area always consumes considerable time and sometimes Nature fails to accomplish it. In such cases skin-grafting is employed (q. v.). Before, during, and for a time after epidermization the fibrous tissue of the walls and base of the wound contracts. Thus the wound margins are pulled and held nearer together, the gap to be bridged is diminished in size, the danger of tearing apart of the epithelial coat is lessened, many capillaries are destroyed by pressure, and the scar becomes firm, white, and puckered. Cicatrization consists in the conversion of immature connective tissue into

mature fibrous tissue and in the contraction of the new fibrous tissue. If infection is severe, destruction will exceed repair and healing will not occur. In such a case there is coagulation necrosis of granulation tissue, and the wound becomes covered with tissue remains (aplastic lymph). If granulations rise above the cutaneous level, healing will not take place, because the epithelium cannot then



Fig. 66.—Blood-vessels in granulation (Gross).

grow over the raw surface. A wound in this condition is said to possess exuberant granulations, or proud flesh. In some cases the granulations are pale
from insufficient blood-supply, and in others edematous from venous congestion.
Contraction of the fibrous tissue may be insufficient because there is adhesion
to deep unyielding fascia or to periosteum. Excessive contraction is frequent
after burns and often produces terrible deformity. The scars or cicatrices of
burns contain much elastic tissue. Infected wounds and ulcers heal by second
intention.

Healing by Third Intention.—This consists in the union of two granulating surfaces, the granulations of one side fusing with the granulations of the other side. It is seen in the union of collapsed abscess-walls. The surgeon occasionally seeks to obtain union of a wound several days old by third intention by approximating two granulating surfaces. If the surfaces are aseptic, he will often succeed. The process follows what is known as secondary suturing. It is not unusual to pack a wound with iodoform gauze to control oozing. When this is done it is customary to pass the sutures, but not to tie them. After a few days the gauze is removed and the sutures are tied. This plan renders healing much more rapid than would be possible by the process of healing by second intention.

Cicatrices or Scars.—The newly-formed connective tissue which constitutes a scar will be present in large amount if more granulations were formed than were really necessary for repair or if a considerable defect was repaired.

A recent scar contains fibrous tissue, many fibroblasts, and numerous blod-vessels but no nerves, lymphatics or elastic fibers. The skin above recent scars is usually red because of the numerous vessels beneath it and the layer of epidermis is well developed. In old scars fibroblasts have disappeared and fibrous tissue really constitutes the cicatrix. Some blood-vessels disappear and the diameters of those remaining are much reduced. These vascular changes result from contraction of the cicatrix. Delicate elastic fibers appear in old

scars. They appear at the end of the second month in wounds healed by first intention, at the end of the third or fourth month in wounds healed by second intention, and they take origin directly from cell protoplasm and not from fibrous tissue (Minervini, in "Virchow's Archiv," vol. 175, No. 2). No genuine lymphatics exist in old scars but occasionally nerve filaments are present. Some dermal papillæ are found after a time, but skin glands, skin muscle, and hair follicles remain absent.

An old scar is smooth, whiter than the surrounding skin, somewhat creased or wrinkled and deficient in tactile sense. The scar of a healed tuberculous ulcer is irregular, livid, and often actually corrugated. The scar of a healed syphilitic ulcer is at first coppery-red and then glistening white and depressed. The scar of an old ulcer of the leg and of the skin about it is often darkened by pigmentation.

A cicatrix may be discolored by retained foreign bodies, for instance,

grains of gunpowder.

During scar formation shreds of epidermis may be displaced and included in granulation tissue. Subsequently they are included in fibrous tissue and may then give rise to transplantation (*implantation*) dermoids or to epithelial tumors. A scar may be deformed, for instance, may be greatly depressed and adherent to underlying bone, and in certain situations such a scar will fix the jaws or any other joint. The *vicious cicatrix* is a great excess of a scar tissue and results from delayed healing by second intention. Such cicatrices are particularly common after burns and tuberculous ulcerations. In some cases the scar is irregular and lumpy, in other cases it is thickened at certain parts and discolored and resembles keloid.

A cicatrix may block a natural orifice, as the mouth or nostril; may produce great deformities, for instance, the head may be drawn upon the chest or shoulder by a contracting scar in the neck, fingers may be grown together after a burn, or a hideous depression may exist on the forehead after an injury, or the face may be fearfully contorted by contracting cicatrices. A scar may produce great disability by blocking the jaws, obstructing the rectum or ure-thra, or fixing a joint or certain muscles of an extremity.

Most scars are insensitive, some are hypersensitive. The hypersensitive scars are usually thin and pale. The itching, burning or tingling appreciated in a sensitive scar are located, as a rule, at the junction of sound skin and newly-formed epidermis. Sometimes acute neuralgic pain exist in and about a scar due to pressure upon nerve filaments.

A scar may inflame or ulcerate, warts may spring from its cutaneous surface, keloid may arise from the fibrous tissue, carcinoma may come from the epithelial elements (Marjolin's ulcer), sarcoma from the connective-tissue elements.

Healing of Subcutaneous Wounds.—Blood fills the tissue gap and the blood-clots. Plasma exudes and corpuscles migrate into the clot and the tissue about it. The clot is eaten up by the leukocytes. The connective-tissue cells and the endothelial cells of the adjacent tissue proliferate and form fibroblasts, and fibroblasts multiply and replace the clot. The area of fibroblasts is vascularized by the formation of new capillaries, and fibrous tissue forms and strongly contracts.

Healing of Wounds in the Non-vascular Tissues.-Inatrivial injury

of the cornea a few leukocytes gather from the lymph-spaces and a few of the fixed cells proliferate. When the cornea is more severely wounded, an increased flow of lymph occurs. The nerves are irritated, vessels adjacent to the cornea distend, and many leukocytes invade the lymph spaces. The corneal corpuscles multiply and alter in shape. The product of the process may be transparent if fibrin is absorbed and leukocytes pass away, because proliferating corneal corpuscles form transparent tissue. The surface epithelium is replaced by proliferation of the deep layer of corneal epithelium. If the wound has penetrated the posterior portion, it is filled by proliferating epithelium from the membrane of Descemet. In a severe injury of the cornea endothelial cells and corneal corpuscles proliferate, vessels grow in from the corneal margins toward the seat of inflammation, fibrous tissue forms, and permanent opacity results.

Repair in cartilage, if it occurs at all, is very slow and is accomplished in the same way as repair in the cornea. Any severe injury is repaired by white fibrous tissue, furnished by the cells of the perichondrium, and the scar is

**Cell-division.**—The multiplication of connective-tissue cells in repair may be by direct, but is usually by indirect, cell-division. *Direct cell-division* consists in division of the nucleus followed by division of the entire cell.

Indirect cell-division, or karyokinesis, takes place after remarkable changes in the nucleus. The membrane of the nucleus disappears; the nuclear network becomes first close and then more open; and the cell becomes round, if not so before. The network of the nucleus, now consisting of one long fiber, takes the shape of a rosette; next it takes a star form—the aster stage; two sets of V's next form—the equatorial stage; an equatorial line appears and widens, and each set of V's retreats toward a pole. Thus two new nuclei are formed, each polar V passing in inverse order through the previous changes of shape, and the protoplasm of the original cell collecting about each nucleus (Fig. 67).

Repair of Nerve.—A nerve-fiber consists of a core known as the axiscylinder, which is the essential element in function. About the axis-cylinder is an almost liquid material, known as the medullary sheath or white substance of Schwann, or myelin. The myelin is surrounded by a firm sheath known as the neurilemma (sheath of Schwann, primitive sheath, neurolemma). On its inner surface, or between it and the white substance of Schwann, are nuclei which are supposed by some to be peripheral nerve-cells (neuroblasts). The neurilemma is absent in the brain and cord. The continuity of the white substance of Schwann is interrupted at frequent intervals, and these breaks in the myelin are called nodes of Ranvier. Numbers of fibers of the kind just described, bound into bundles by connective tissue and surrounded by a fibrous sheath, constitute a nerve. It is known that a nerve may be regentrated and completely regain function after division; that regeneration is strongly favored by suturing the ends together; and that if the ends of a divided nerve are more than one inch apart, regeneration will rarely take place unless they are sutured together. The method by which regeneration is affected has been much disputed and is still involved in uncertainty. If a nerve is divided, the peripheral segment at once loses its function and then undergoes degeneration (Wallerian degeneration). The degeneration begins within twenty-four to forty-eight hours and affects the entire peripheral segment. The axis-cylinder perishes, the myelin runs into globules and is absorbed. leaving an almost empty sheath; the nuclei of the inner surface of the neurilemma proliferate for a time, but cease to do so before the myelin is completely absorbed. The sheath shrinks and looks empty, but here and there are collected masses of proliferated nuclei and protoplasm. Degeneration takes place in days, but regeneration requires months. Regeneration takes place by the multiplication of pre-existing nerve-fibers and not by the transformation of connective tissue into nerve structure. The ends of a divided nerve, it is true, are united by connective tissue formed by the proliferation of fibroblasts, but this connective tissue is only a bridge to carry nerve elements across the gap between the proximal and peripheral segments. The common view is that regeneration takes place as follows: The new axis-cylinder of the peripheral segment is a prolongation of the old axis-cylinder of the proximal segment, projected in the following manner. A fiber, which is at first devoid of myelin, is prolonged from a proximal axis-cylinder; it divides into many cylinders, which pierce the granulation tissue between the ends and enter into the empty sheaths of Schwann of the distal segment or insinuate themselves between these sheaths (Ranvier, Réclus, Senn). The above is the view entertained by those who teach that the new axis-cylinders come entirely and only from the prolongation of old axis-cylinders of the proximal segment, and that the distal segment is passive in the process until "neurotised" (Vanlair), and that regeneration is impossible in the distal segment unless it is in approximation with the proximal segment or within easy reach of the prolongations of the axis-cylinders from above. Another view is that the axis-cylinders, myelin, and neurilemma are formed from cells which exist in the distal segment, and that juvenile axis-cylinders and medullary sheaths are formed in the peripheral portion and then effect a junction with like structures of the central segment. The last-mentioned view is advocated by Mayer and Eichhorst, Tizzoni, Cattani, and others, and Ballance and Stewart have recently published a most valuable monograph advocating it ("The Healing of Nerves"). The nuclei proliferate and form a mass of protoplasm within the old sheath, which protoplasm joins the proximal segment. Such a protoplasmic fiber has "conduction and irritability" (Raymond's "Human Physiology"), but there is as yet neither myelin nor axis-cylinder. "The fiber is responsive to mechanical stimuli, but not to induction shocks, which latter property returns only after the axis-cylinder is developed. The medullary substance later appears and forms a tube; and still later the axis-cylinder is formed, having its origin in the central end of the nerve" (Raymond's "Human Physiology"). The views of Ballance and Stewart may be set forth as follows: When a nervetrunk is divided, the peripheral segment degenerates whether it has been sutured to the proximal segment or not, and the portion of the proximal segment near the wound also degenerates. The injury produces at once an effusion of blood, migration of leukocytes takes place into and about the wound at the proximal segment, but leukocytic invasion of the entire distal segment is noted. After three days connective-tissue cells begin to replace the leukocytes, and after two weeks the excess of leukocytes is no longer observed, proliferated connective-tissue cells having taken their place (page 94, "Healing of Nerves"). The proximal segment in the neighborhood of the wound and the entire distal segment are invaded by proliferating connective-tissue cells. The connective-tissue cells completely absorb the fatty myelin and axis-cylinders. The cells of the neurilemma actively multiply, and connective-tissue cells lying among chains of neurilemma cells become spindle-shaped and "the degenerated nerve-trunk therefore becomes hard, fibrous, and cirrhosed" (Ballance and Stewart on the "Healing of Nerves," page 94).

In the proximal end of a divided nerve an "end-bulb" is formed. This was long supposed to be due to the prolongation of nerve-fibers from the central fibers and a turning backward because they cannot cross the gap. As a matter of fact, the ends of the divided fibers curl up; on and in this scaffold-like arrangement new fibers are placed, they having been produced by the neurilemma cells which have taken on "neuroblastic function" (Ballance and Stewart). When a nerve has been sutured, the earliest signs of regeneration "occur at the end of three weeks" (Ballance and Stewart). Short lengths of new fibers are laid down within old neurilemma sheaths. The new axis-cylinder "is seen to consist in the deposition along one side of a spindle-shaped neurilemma cell, of a thin thread which grows in length until it projects beyond the limits of the parent cell and stretches on toward its next neighbor in the same longitudinal row" (Ballance and Stewart). The new medullary sheath is "laid down by a process of secretion" (Ballance and Stewart) along the sides of the neurilemma cells.

Ballance and Stewart go on to point out that if the central theory of regeneration is true, not a trace of regeneration could occur in the distal segment when the two segments have not been united by sutures, and yet such regeneration does occur, although slowly, the new axis-cylinders and medullary sheaths not attaining full size. "Evidently some stimulus afforded by the conduction of impulses is necessary in order to permit of their full development" (Ballance and Stewart). In the notable study quoted at such length are some experiments on the "conduct and fate of transplanted nerve." When the gap is wide between the two ends, a portion of fresh nerve-trunk may be inserted to bridge it. The transplanted piece degenerates; it is invaded by leukocytes, and proliferating connective-tissue cells, medullary sheaths, and axis-cylinders are destroyed, but regeneration may subsequently occur; "but when it does occur, it is not from the activity of the cells of the graft itself" (Ballance and Stewart). Blood-vessels enter the degenerated graft at each end and they are accompanied by chains of neurilemma cells, which form axis-cylinders and medullary sheaths. The graft is merely a scaffold (Ballance and Stewart).

The studies of Ballance and Stewart persuade us that regeneration does occur in the distal part independently of the proximal part, although full development does not take place unless there is a junction with the central part. As to the exact method of regeneration we still feel somewhat uncertain. When we remember that the nerve-fibers of the spinal cord are devoid of neurilemma and that the cord can, to some extent at least, regenerate, we must conclude that regeneration can take place in the cord without the aid of neurilemma cells, and must infer that the same may be true in a nerve.

Repair of the Spinal Cord and Brain.—Can the spinal cord regenerate?

Many observers have doubted it. But there is no doubt of the fact that sometimes, after the subsidence of an acute myelitis or after the relief of a pressure

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which produced complete and prolonged paralysis, there is a return of functional power. It is usually assumed that restoration is possible in fibers which have not been hopelessly damaged, but is not possible in those which have been destroyed; but, as Gowers says, there are cases in which "we can scarcely believe that the axis-cylinders retain their continuity, although conducting capacity is ultimately restored." Clinical evidence indicates strongly that the pyramidal fibers may regenerate. Mills says ("The Nervous System and Its Diseases"): "Nerve-tracts in the spinal cord and brain have power to regenerate, but this is not so great as in the peripheral nerves, and yet even old cases of compression of the spinal cord may make great improvement after a long time, largely through the regeneration of the columns of the cord." Mills affirms that although nerve-cells sometimes appear to regenerate, the destruction in these cases was not complete.

When axis-cylinders have been destroyed in the cord and yet some power returns, we ask ourselves if this occurs because new fibers have grown down from above. Gowers says that such a growth has been proved to occur in the



Fig. 67.—Forms assumed by a nucleus dividing (Green, from Flemming).

lower animals, but has not as yet been demonstrated in man; although specimens have been described which strongly suggest such an occurrence in the human subject. That the cord can regenerate to some extent seems highly probable from the report of a recent case. Dr. Francis T. Stewart, of Philadelphia, sutured a com-

pletely divided spinal cord and an extraordinary restoration of function took place (Francis T. Stewart and Richard H. Harte, in "Phila. Med. Journal," June 7, 1902). This case is commented on at some length in the section on Injuries of the Spinal Cord. Another somewhat similar case was reported by George Ryerson Fowler in the "Annals of Surgery," Oct., 1905.

Many claim that a brain injury cannot be followed by repair with restoration of function; some think that complete regeneration can take place; others, that partial regeneration may occur. Vitzon and Tedeschi even believe that nerve-cells in the brain can regenerate. It seems probable that extensive injuries are not repaired, but slighter ones may be, new ganglion-cells and neuroglia being formed. Tedeschi describes the process of repair after a wound of the brain as follows: Degeneration occurs and a limited focus of necrosis forms and then the adjacent tissue shows evidences of repair. Capillaries form from the endothelial cells, glia tissue from the neuroglia, ganglion-cells present karyokinetic changes, and some nerve-fibers appear in the scar (Senn's "Principles of Surgery").

Repair of Muscles.—It has long been taught that the repair of muscle by muscle is impossible, and, as a matter of fact, it does not take place if the ends of a divided muscle are separated to the extent of an inch or more. When a muscle is divided transversely by a considerable cut, the ends retract and a wide space is left between them. Blood flows into the space between the ends and also between individual fibers of the injured muscle, and the blood-clots. Exudation of plasma occurs and migration of curpuscles takes place. Fibroblasts are produced by proliferation of connective-tissue cells and a mass of abroblasts soon replaces the blood-clot. Granulation tissue is formed by vascularization of the mass of fibroblasts, and granulation tissue is converted into scar tissue, but not at all into muscle. After slight injuries a trivial amount of muscular regeneration does occur by the multiplication of living muscle-cells, but not by metamorphosis of fibroblasts. Fibroblasts are in-



-Fracture one week : bloodon containing fragment of bone (War- (dog) four weeks: commenc- fifth week after fracture

Fig. 69.-Callus of fracture ing ossification of external (Warren). callus (Warren).

Fig. 70.-Femur of a child

capable of a transformation into muscular tissue. When the ends of a divided muscle are separated only to a very slight degree or when they have been brought together and sutured, some muscular regeneration occurs. After an injury a number of the muscular fibers wither, perish, and are absorbed. The process of regeneration arises from the remaining fibers. The nuclei of the muscle-fiber proliferate and so do the nuclei of the perimysium. The musclecells are called myoblasts and the nuclei of the perimysium are called sarcoblasts. About the juvenile muscle-cells a deposit of protoplasm takes place (Weber). The embryonal cells gradually become spindle-shaped and muscular fiber is formed by cellular fusion or by elongation of individual cells.

The above remarks refer to striated muscle. Unstriated muscle fibers are repaired solely by "indirect multiplication of their nuclei" (Senn).

If a muscle has been divided, it should be sutured. This process insures more rapid repair and secures a better functional result, and is followed by

a much greater amount of muscular regeneration.

Repair of Tendon.—When a tendon is divided, the ends retract, and the sheath, as a rule, becomes filled with blood-clot. The blood-clot is rapidly removed, fibroblasts replacing it. This new tissue arises from the sheath, the cut ends of the tendon not participating in its formation. Granulation tissue is formed; this is converted into fibrous tissue, and after a time the fibrous tissue becomes true tendon. If no blood-clot forms in the sheath, the walls of this structure collapse and adhere, and the separated tendon-ends are held together by a flat fibrous band formed from the collapsed sheath

(Warren's "Surgical Pathology").

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Repair of Bone.-When a bone is broken, a blood-clot quickly forms in the medullary cavity, between the broken ends and under and outside the periosteum. Leukocytes invade and destroy the clot. The cells outside the periosteum, the cells of the periosteum and of the medullary tissue, particularly the endothelial cells, proliferate and produce cells which are practically fibroblasts. The osteoblasts in the medullary tissue, and perhaps in the deeper layers of the periosteum, multiply and are distributed through the mass of fibroblasts. The osteoblasts may form bone directly or may form cartilage first. Some teach that fibroblasts can be converted into bone; others positively deny such a conversion. The point is not settled, but it is well to remember that in myositis ossificans a muscle is converted into bone, and hence that it is probable that fibroblasts, formed from periosteum and medullary tissue, should be much more prone to undergo such a development. During regeneration the bone ends soften and are partially absorbed by osteoclasts. These cells are large osteoblasts which have lost the power of bone production and furnish a secretion which dissolves osseous matter. The excess of callus is finally absorbed by osteoclasts. (For a more extended description see Repair of Fractures.) Sir Wm. Macewan has recently denied that the periosteum plays a leading rôle in bone production ("Brit. Med. Jour.," June 22, 1907). He believes that the periosteum is a membrane to limit and control the osteoblasts and that new bone is formed from bone cells. There is much experimental evidence to confirm Sir William's assertion. If he is correct a considerable osseous defect will not be filled up by new bone even if the periosteum

Repair of Blood-vessels.—If an artery is cut across and ligated, a clot forms within its lumen and about its divided end, and the circulation in the vessel at this point is permanently arrested. The proximal clot, it used to be thought, always reaches the first collateral branch. This statement was true before the days of asepsis; it is not always true now. Often a clot stops far short of the branch above. Exudation of plasma and migration of corpuscles take place from the vasa vasorum. The clot becomes filled with leukocytes, which gradually destroy it, and it plays no active part in repair. Fibroblasts form by the multiplication of the cells of the vessel wall and the clot is soon replaced by fibroblasts. The fibroblasts are converted into granulation tissue, granulation tissue becomes fibrous tissue, the fibrous tissue contracts, and the artery is transformed into a fibrous cord (Fig. 220). Warren insists that the muscle-cells of the middle coat play an active part in repair. Usually, when a ligature is applied to an artery in continuity, a deliberate attempt is made to

rupture the internal and middle coats, in order to permit of contraction and retraction above and below the seat of ligature, and a turning inward of the inner coat. Such a sequence of events happens when an artery is completely divided across and not tied, and favors the rapid formation of a clot.

Ballance and Edmunds ("Ligation in Continuity") maintain that repair is obtained most rapidly when the artery is tied with two ligatures, the vessel at this point being deprived of blood, but the internal and middle coats being kept intact. Cell-proliferation forms a spindle-shaped mass of new cells and the lumen is obliterated at the seat of ligation by fibroblasts obtained from the fixed cells of the wall of the artery. Senn advocates the employment of two ligatures, not placed side by side as in the method of Ballance and Edmunds, but so applied as to include "a bloodless space about half an inch in length" (Senn's "Principles of Surgery").

When a lateral ligature is applied to a vein or when a small wound in a vein or artery is sutured, the circulation in the vessel is not completely cut off, a thrombus of small size is formed on the vessel-walls, the fixed cells of the vessel-wall proliferate, and a scar of fibrous tissue effects repair. A completely divided vein heals as does a completely divided artery (Fig. 221). The clot after the aseptic application of a ligature to a vein may be of slight extent, but in some cases the proximal clot reaches the first collateral branch and in others goes far above it.

Repair of Skin.—The fibrous structure is repaired by fibrous tissue. Hair follicles, sweat-glands, and sebaceous glands are not reformed. The epithelial layer is regenerated by the proliferation of adjacent epithelial cells.

Repair of Lymphatic Tissue.—Lymphatic tissue can regenerate either from the fatty tissue, the divided ends of the lymph ducts or both structures.

Repair of the Kidney and Testicle.—These organs when damaged can

undergo some regeneration.

Repair of the Liver and Spleen.—Each of these organs, after injury, is capable of considerable regeneration.

## V. SURGICAL FEVERS.

The surgeon encounters fever as a result of an inflammation or an aseptic wound, in consequence of infection, as a result of poisoning by certain drugs, and in several maladies of the nervous system. It is important to remember that, while elevated temperature is generally taken as a gauge of the intensity of fever, it is not a certain index. There may be fever with subnormal temperature (as in the collapse of typhoid or pneumonia), and there may be elevated temperature without true fever (as in certain diseases of the nervous system). It is true, however, that elevation of temperature is almost always noted, and is usually accepted as the measure of the severity of the fever.

The essential phenomena of jever, according to Maclagan, are—(1) wasting of nitrogenous tissue; (2) increased consumption of water; (3) increased elimination of urea; (4) increased rapidity of circulation; and (5) preternatural heat

Traumatic fevers follow a traumatism and attend the healing or infection of a wound. The forms are —(1) benign traumatic fever; (2) malignant traumatic fever.

Benign traumatic fever is divided into two forms—the aseptic and the septic. There is but one form of aseptic fever, the post-operation rise. The septic benign fevers are surgical fever and suppurative fever. The malignant traumatic fevers are sapremia, septic infection, and pyemia. In this section

we discuss only the benign fevers.

Aseptic traumatic fever, or the post-operation rise, often, but not always appears after a thoroughly aseptic operation and after a simple fracture or a contusion. It is not preceded by a chill, by chilliness, or by a feeling of illness. It may appear during the evening of the day of operation or not until the next day, and reaches its highest point by the evening of the second day (100° to 103° F.). This elevation is spoken of as the "post-operation rise" because it is usually encountered after an operation. Besides the elevated temperature there are no obvious symptoms; the patient feels well, sleeps well, and often wants to sit up; there are no rigors and there is no delirium. The wound is free from pain and appears entirely normal. But examination may show moderate leukocytosis. This fever is due to absorption of pyrogenous material from the wound area, the material being obtained from clot or inflammatory exudate, or from both. Many observers believe that the pyrogenous element is fibrin ferment, which is absorbed from disintegrating blood-clot and coagulating exudate. Warren thinks the fever is due to fibrin ferment, and "also to other substances slightly altered from their original composition during life." Some have asserted that the fever is due to nervous shock.

Schnitzler and Ewald have recently studied aseptic fever.\* These observers maintain that aseptic fever can exist when no fibrin ferment is free in the blood, that fibrin ferment can be free in the blood when there is no fever, and, in consequence, that fibrin ferment is not the cause of the elevation of temperature. They rule out of consideration nervous shock as a cause, and assert that a combination of several factors is responsible, nucleins and albumoses which are set free by traumatism being looked upon as the most active causative agents. The presence of nuclein in the blood in aseptic fever is indicated by leukocytosis and by the increase of the alloxur bodies (including uric acid) in the urine. The capacity of nucleins and albumoses to cause fever is greater in the tuberculous than in the non-tuberculous, and we know clinically that a tuberculous patient is apt to exhibit a more violent post-operation rise than is a non-tuberculous subject. The diagnosis of aseptic traumatic fever is only to be made after a careful examination has assured the surgeon that there is no obscure or hidden area of infection.

In some cases aseptic fever may appear after an operation, and later be replaced by a septic fever. If the temperature remains high after a few days, if other symptoms appear, or if after the temperature has become normal it again rises, the wound should be examined at once, as trouble almost certainly exists.

True traumatic or genuine surgical fever is seen as a result of infected wounds in which there is decided inflammation, but no pus. The real cause is the presence of fermentative bacteria in the wound and the absorption of a moderate amount of their toxic products. The most active and commonly present organisms are those of putrefaction. Surgical fever ceases as soon as free discharge occurs, and the ap-

<sup>\*</sup>See Archiv für klinische Medicin, Bd. liii, H. 3, 1896; also statement of their views in Medical Record, Dec. 19, 1896.

pearance of such a fever is an indication for instant drainage. condition is ushered in two or three days after the operation by chilly sensations and general discomfort. The temperature rises pretty sharply, ascends with evening exacerbations and morning remissions, and reaches its height about the third or fourth day, when suppuration sets in; the temperature begins to drop when pus forms, if the pus has free exit, and reaches normal at the end of a week (see Suppurative Fever). The temperature may reach 104° F. or more, but rarely rises above 103° F. The patient has the general phenomena of fever, that is to say, thirst, anorexia, nausea, dry and coated tongue, constipation, pain in the back and legs, and headache. The urine is scanty and high-colored. Blood examination usually shows decided leukocytosis. The wound is painful, tender, swollen, discolored, and often foul, and stitch-abscesses may form. Some or all of the stitches must be cut, and the area should be asepticized, and packed with iodoform gauze or drained by a tube. The fact that this fever is apt to cease when discharge of pus begins led the older surgeons to hope for pus and to endeavor to cause it to form. A severe grade of surgical fever, such as arises when there is putrefaction in a large and ill-drained wound, is due to the absorption of a large quantity of the toxic products of putrefactive bacteria and is known as sapremia (page 209).

Suppurative Fever.—This fever, which is due to the absorption of the toxins of pyogenic organisms, occurs after suppuration has begun, is found when the pus has not free exit, and is an intoxication rather than an infection. Item follow or be associated with surgical fever, or may arise in cases in which surgical fever has not existed. Suppuration in a wound is indicated by a rapid rise of temperature-possibly by a chill. The temperature rises to a considerable height, shows morning remissions and evening exacerbations, and as it begins to fall toward morning sweating occurs. The patient is much exhausted and presents the phenomena of fever previously described. The skin about the wound becomes swollen, dusky in color, and edematous, pain becomes pulsatile, and much tenderness develops. Blood examination shows very marked leukocytosis. The wound must at once be drained and asepticized. In a chronic suppuration, such as occurs when there is progenic infection of a tuberculous area, there exists a fever with marked morning remissions and vesperal exacerbations, attended with drenching hight-sweats, emaciation, diarrhea, and exhaustion. This is known as hectic har; it is really a chronic suppurative fever. The treatment of hectic fever consists in the drainage and disinfection, if possible, the excision of the infected the employment of a nutritious diet, stimulants, tonics, remedies for the exhausting sweats, and free access of fresh air.

Some Other Forms of Fever Seen by the Surgeon.—Fever of Tension.—When there is great tension upon the stitches the spots where the stitches perforate ulcerate and some fevers arise. To relieve the fever of tension cut one or several stitches. This fever is in some cases surgical, and in some suppurative, according as to whether the infective organisms cause fermentation or suppuration.

Fever of Iodoform Absorption (see page 31).

Fever of Ptyalism, or Mercurial Fever (see page 334).

Fever of Morphinism.—Sometimes a morphia habitué suffers from severe chills and intermittent fever of the quotidian or tertian type. The condition is usually thought to be malarial, a view which is strengthened by the common association with neuralgia; but quinin proves futile as a remedy and blood-examination gives a negative result. If we have reason to suspect that the patient is using morphia, examine the urine for the drug and wash out the stomach and examine the washing. The latter test is of value even when morphin is used hyperdermatically, because that drug is excreted into the stomach.

Fever of Cocain-poisoning (see Local Anesthesia).

Hepatic Fever (see section on Liver and Gall-bladder).

Hysterical Fever.—This remarkable condition is occasionally, though seldom, encountered. Most of the reported cases of great hyperpyrexia are instances of simulation and fraud. It may happen that elevated temperature is the sole evidence of illness, there being no wasting or other febrile symptoms. Such elevated temperature may be attained daily for months. As a rule, hysterical stigmata can be detected. Osler points out that cases of hysterical fever "with spurious local manifestations" are very deceptive. The case may resemble meningitis, peritonitis, or some other acute inflammatory condition; but the course of the supposed malady is found to be atypical and the symptoms are observed to be variable and often anomalous. There is no leukocytosis; frequently there is an apparent increase in red cells because of vasomotor disturbance, a fall in hemoglobin, and an increased proportion of lymphocytes and eosinophiles ("Clinical Hematology," by J. C. DaCosta, Jr.).

An emotional fever sometimes occurs after accidents or operations. The patient may have a chill, and then develop violent headache, photo-

phobia, and hysterical excitement, with elevated temperature.

Malaria.—It is wise to examine the blood in supposed septic fevers, for only by this means can malaria be excluded. It is more common to mistake sepsis for malaria than malaria for sepsis. In malaria the spleen is enlarged, the febrile attacks exhibit periodicity, neuralgias are common associates, and

quinin cures the condition.

Surgical Scarlet Fever.—It is maintained by some writers (notably Sir Victor Horsley and Sir James Paget) that a child is rendered especially susceptible to scarlet fever by the shock of a surgical operation. Scarlet fever which develops after a wound, a burn, or an operation is spoken of as surgical scarlet fever. Warren quotes Thomas Smith as having had ten cases of scarlet fever in forty-three operations of lithotomy in children. The puerperal state is supposed also to predispose to scarlet fever. It is not certain whether the poison enters by the wound, or whether shock and exhaustion predispose to ordinary scarlatina, or whether ordinary scarlatina was incubating before the accident or operation. Some surgeons hold that an attack of scarlet fever after an operation is a mere coincidence. Others maintain, and with great show of reason, that a red scarlatiniform eruption appearing after an operation, rarely indicates genuine scarlet fever, but usually points to infection, as such eruptions are known occasionally to arise in septicemia. It rarely indicates scarlet fever, and yet it sometimes does. There is such a condition as surgical scarlet fever, as is proved by the facts that victims of the disease have been known to communicate it, and that it is often followed by "nephritis and usually by desquamation" (Holt's "Diseases of Infancy and Childhood").

Hoffa has discussed this subject elaborately. He concludes that four types of eruption can follow operation: (1) a vasomotor disturbance due to irritation of sensory nerves, and manifested by a transient urticaria or erythema; (2) a toxic erythema due to absorption of aseptic pyrogenous material from the injured area—the absorption of carbolic acid, iodoform, of corrosive sublimate, or the effect of ether; (3) an infectious rash which is sometimes found in septicemia or pyemia, and is due to minute emboli composed of bacteria, which emboli lodge in the capillaries; (4) true scarlet fever, with the usual symptoms and complications, the micro-organisms having entered by way of the wound and the eruption often beginning at the wound edges (quoted in Warren's "Surgical Pathology"). Surgical scarlatina is aberrant. It develops rapidly, the period of incubation is extremely brief, and the throat may or may not be involved. Holt tells us that the rash is usually atypical and that "the general symptoms, particularly those relating to the nervous system," are "especially severe" ("Diseases of Infancy and Childhood"). The infection is believed to be due to a specific germ, but it has not been certainly identified. Streptococci have been found in the throat, skin, and the pus from secondary otitis media.

If surgical scarlet fever develops the wound should be drained and asepticized, and if the situation admits of it, dressed with hot antiseptic fomentations. The general treatment is the same as for ordinary scarlatina.

Urinary Fever and Urethral Fever (see section on Disease of Genito-urinary Organs).

Syphilitic Fever (see page 318).

Thyroid Fever (see section on Thyroid Gland).

## VI. SUPPURATION AND ABSCESS.

SUPPURATION is a process in which damaged living tissues and inflammatory exudates are liquefied by the action of pyogenic organisms, and it is a common result of microbic inflammation. The organisms which are responsible are referred to on page 47. Staphylococci tend to produce local suppuration; streptococci tend to cause spreading suppuration. It is generally taught that Pyogenic bacteria liquefy damaged tissue and exudate by peptonizing them, the active agent in effecting the chemical change being poison furnished by the bacteria. There is some evidence that white corpuscles by disintegration set free enzymes which dissolve or aid in dissolving albumin. Streptococci and staphylococci vary greatly in virulence and the intensity and diffusion of a pyogenic infection depends upon the virulence and number of the bacteria and the level of vital resistance. Streptococci and staphylococci may both be present in one focus, and there may be secondary infection with bacteria of putrefaction or other bacteria. The pyogenic infection may be primary or it may be secondarily implanted in a diseased area containing other micro-organisms. The pyogenic organisms are very irritant, and when deposited cause infammation; inflammation leads to exudation, but the exudate cannot coagulate or coagulates but imperfectly, because it is peptonized by the ferment of the micro-organisms and also perhaps because albumin is dissolved by leukolysin from the white corpuscles. If an area of embryonic tissue is

invaded by the pyogenic micro-organisms, it is promptly peptonized. The peptonizing action is upon the fibrinous elements of an exudate and upon the intercellular substance of embryonic or granulation tissue. Cells are separated from intercellular substance, and in consequence degenerate and die. Peptonized exudate or peptonized embryonic tissue is called pus. In suppurations induced by staphylococci a barrier of leukocytes is first formed around the region of irritation; this barrier is reinforced by fibroblasts, the pus is imprisoned, and rapid spreading and wide diffusion are prevented. In inflammations induced by streptococci the peptonizing action of the organisms is so great that no barrier of white blood-cells or of proliferating connective-tissue cells forms in time to imprison the micro-organisms; hence the suppuration spreads rapidly and widely. Suppuration can be induced by the injection of pyogenic bacteria, by their entry through a wound, and by rubbing them into the skin. In some rare instances, especially when the diet has been putrid, they may enter through the blood and lodge at a point of least resistance. When a medullary canal suppurates after a chill to the surface or after a blow that does not cause a wound, we know that the bacteria must have arrived by means of the blood. Bacteria which reach a point of least resistance through the blood come from some atrium of infection which may be discoverable or which may not be found. The entry of pyogenic bacteria does not necessarily cause suppuration, as the healthy human body can destroy a considerable number, even if given in one "dose"; but a large number in a healthy, or even a small number in an unhealthy body, almost certainly leads to pus-formation. The pus of all acute abscesses contains bacteria of suppuration, but the pus of tuberculous abscesses does not, unless there be a mixed infection; in other words, pure tuberculous pus is not pus at all.

Can suppuration be induced without the actual presence of bacteria? It is true that the injection of irritants can cause the formation of a thin fluid which contains no bacteria; but this non-bacterial fluid is not pus. A purulent fluid is formed by injecting cultures of pus cocci which have been rendered sterile by heat, the bacteria having been killed, and a ferment contained in the bacterial cells being the active agent. Purulent material also results from the injection simply of the sterile products of the growth of pyogenic cocci. This purulent or sterile fluid is known as *spurious* or *aseptic pus*. An area of such aseptic suppuration does not tend to spread and the process concerns us but little as surgeons, except in cases of pyemia in which thrombi containing toxins alone

may occasionally induce limited secondary abscesses.

Impaired health or an area of lowered vitality predisposes to suppuration. Diabetes and albuminuria are common and influential predisposing causes, because in these diseases tissue resistance is always at a low ebb. The lymphatic glands, medulla of bones, serous membranes, and connective tissue are especially prone to suppurate.

Pus may form within twenty-four hours after bacteria have been deposited, or it may not be formed for days. The older surgeons claimed that pus could do good by protecting granulations and separating disorganized tissue. It is now held that it is absolutely harmful by melting down sound tissue and poisoning the entire organism. Modern surgery has to a great degree abolished pus.

If pus stands for a time, it separates into two portions—(1) a watery por-

tion, the liquor puris or pus-serum, containing peptone, fat, microbic products, osmazone, and salts, and not tending to coagulate; (2) a solid portion, or sediment composed of dead and living micro-organisms of suppuration, connective-tissue cells, often epithelial cells, perhaps red blood-cells, lymphocytes, pus-corpuscles (Fig. 71), débris of tissue, and shreds of dead tissue. The pus-corpuscles are either polynuclear white blood-cells or altered connective-tissue cells containing many nuclei. Some of them are dead, some have ameboid movements, some are fatty, others are granular and contain more than one nucleus, and all are degenerating. A pus-cell is waste matter, and it cannot aid in repair. Very exceptionally pus disappears by absorption, by caseation, or by calcification.

Pus in General.—The color of pus is variable and depends upon the nature of the bacteria; the presence or absence of blood, fibrin, body secretions

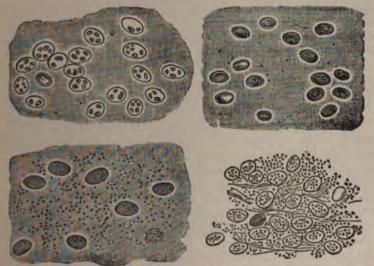


Fig 7L-Fragmentation of nucleus in leukocytes undergoing transformation into pus-corpuscles (Senn).

or body excretions (bile, urine, mucus, feces, etc.); and the existence or non-

Its consistence varies. In some cases it is scarcely thicker than water, in others it is like cream and in still others it is cheesy. Thick pus is usually of a greenish-yellow color and thin pus has usually a reddish or yellowish tinge (Leonard Freeman). When freshly evacuated many varieties are almost or quite odorless, and are alkaline or slightly acid in reaction.

Some varieties possess a very offensive odor. Pus contaminated by the tacteria of putrefaction is certain to have a foul odor. Pus which forms in the tonsil, in the brain, about the vermiform appendix, or around the rectum usually possesses an offensive odor.

Forms of Pus.—Laudable, or healthy pus, a name long in vogue, is a contradiction, no pus being healthy. In former days free suppuration after an operation was regarded as a favorable indication, and when it occurred the

surgeon congratulated himself that surgical fever was at an end. At the present day suppuration after an operation is an evidence of previous infection, of lack of care, failure in our precautions, or of infection by the blood. The so-called *laudable pus* is seen coming from a healing ulcer, and is an opaque, yellowish-white, or a greenish fluid of the consistence of cream, without odor or with a very slight odor if it is not putrid, and having a specific gravity of about 1030.

Malignant, watery, or ichorous pus is a thin, watery, putrid fluid. It is

pus filled with the organisms of putrefaction.

Stinking pus may be ichorous. Its odor may be due to the bacterium coli commune. If this bacterium is the cause the pus is very foul, but not thin. Pus of this nature is met with in ischiorectal abscess and appendiceal abscess. Its odor may be due to ordinary bacteria of putrefaction, in which case the pus is thin.

Sanious pus is a form of ichorous pus containing blood coloring-matter or blood. It is thin, of a reddish color, and very acrid, corroding the parts that it comes in contact with. It is found notably in caries and carcinoma.

Concrete or fibrinous pus, which contains flakes of fibrin or coagulated fibro-purulent masses, is met with in serous cavities (joints, pleura, etc.). These masses also form in infective endocarditis.

Red pus signifies the presence of the bacillus prodigiosus.

Blue Pus.—The color of blue pus is due to the bacillus pyocyaneus.

Orange Pus.—The color of orange pus is due either to the action of sarcina aurantiaca, or to the formation of crystals of hematoidin from the coloring-matter of red blood-cells which have been mingled with the pus. Pus of this color appears only in violent inflammations.

Serous pus is a thin serous fluid containing a few flakes.

So-called tuberculous, scrojulous, or curdy pus is not pus at all, unless the tuberculous area has undergone pyogenic infection.

So-called gummy pus arises from the breaking down of a gumma which

has outgrown its own blood-supply. It is not pus.

Muco-pus is found in purulent catarrh—that is, in suppurative inflammation of an epithelial structure. It contains pus elements and epithelial cells.

Caseous pus comes from the fatty degeneration of pus-corpuscles or inflammatory exudations. It occurs especially in tuberculous processes. A

caseous mass may calcify.

Signs and Symptoms of Suppuration.—Suppuration is announced by the intensification of all local inflammatory signs. The heat becomes more marked, the discoloration dusky, the swelling augments, the pain becomes throbbing or pulsatile, and the sense of tension is greatly increased. The skin at the focus of the inflammation after a time becomes adherent to the parts beneath, and fluctuation soon appears. This adhesion of the skin is a preparation for a natural opening, and is known as *pointing*. An important sign of pus beneath is edema of the skin. This is always observed in a superficial abscess, and is sometimes noticeable in empyema or pyothorax, in appendiceal abscess, and in perirenal suppuration. The above symptoms can be reinforced and their significance proved by the introduction of an aseptic tubular exploring needle and the discovery of pus. Irregular chills, high fever, drenching sweats, weakness, and a feeling of serious sickness are very significant of suppuration in an important structure or of a large area. It must always be remembered that in

some virulent pyogenic infections the human organism is overwhelmed with toxins and although the patient is desperately ill the temperature is normal or even subnormal. In abscess of the brain the temperature may be normal or subnormal.

Diffused Cellulitis or Phlegmonous Suppuration; Purulent Infiltration.—This process may involve a small area or an entire limb, and is due to infection by the streptococcus pyogenes (or streptococcus of erysipelas) usually associated with mixed infection with other bacteria particularly the bacteria of putrefaction. The streptococci are intensely virulent. Barriers of white corpuscles will not restrain them, and tissues break down before cellular multiplication is able to encompass the bacteria. The bacteria disseminate through the lymph-spaces and lymph-vessels. The disease in severe cases produces enormous swelling, areas which feel boggy, a dusky red discoloration, and great burning pain. Gangrene of superficial areas is not unusual, due to thrombosis of vessels or coagulation necrosis from toxins. The discharges of the wound, if a wound exists, are apt to dry up, and the wound becomes foul, dry, and brown. The adjacent lymphatic glands are much enlarged. The disease is ushered in by a chill, which is followed by high oscillating temperature, due to suppurative fever, sapremia, or even septic infection or pyemia. Sweats are noted during falling temperature. Diffuse suppuration tends to arise in infected compound fractures, in extravasation of urine, and after the infliction of a wound upon a person broken down in health. It is not unusual after typhoid or scarlet fever, and is typical of phlegmonous erysipelas. The pus is sanious and offensive, and burrows widely in the subcutaneous tissue and intermuscular planes. This diffused suppuration may widely separate muscles and even lay bare the bones. It is a very grave condition, and may cause death by exhaustion, septic intoxication, septic infection, pyemia, or hemorrhage from a large vessel which has been corroded. Cellulitis of a mild degree is due to attenuated streptococci or to staphylococci. An area of cellulitis may surround an infected wound or a stitch-abscess. Its spread is manifested by red lines of lymphangitis running up to the adjacent lymphatic glands. Light cases may not suppurate, the lymphatics carrying off the poison. Any case of cellulitis is, however, a menace, and any severe case is highly dangerous (see

Wooden or Ligneus Phlegmon.—This condition was fully described by Réclus in 1894. It is chronic inflammation of the cellular tissue and fascia of the neck. It is a very chronic condition beginning with hard swelling of one sideor of the front of the neck and for weeks is unaccompanied by any other sign. The swelling may be at first localized, but it spreads slowly and widely and fmally comes to involve an extensive area, even perhaps the front of the neck and both sides from the jaw to the collar-bone. It may involve the cervical muscles and thus create rigidity and it may compress the larynx and trachea and thus interfere with breathing. After weeks or perhaps a month or two the skin becomes edematous and red or rather of a violet hue. There is rarely pain and the significant facts are the gradually advancing hard swelling long unaccompanied by pain, discoloration, or cutaneous edema. The condition is due to the deposition and multiplication of pyogenic bacteria which reach the tissues from the lymph-glands and reach the glands from the mouth. Pus does not form at all or only minute encapsuled foci form because the bacteria are of

greatly attenuated virulence or because the local vital resistance is at a high level to these bacteria. Inflammation occurs, there is copious exudate and enormous amounts of fibrous tissue form.

Wooden phlegmon is occasionally found in syphilitics and is most apt to arise in those in poor health. It is frequently mistaken for sarcoma or carcinoma, in fact Lange believes it to be cancer. Wooden phlegmon is always dangerous and is frequently fatal.

Treatment.—Extirpation is not feasible and the surgeon instead makes numerous incisions and usually dresses with an antiseptic poultice. In these cases free suppuration occasionally occurs after a long delay and when it does occur a cure may promptly follow evacuation. If free suppuration were induced to occur by inoculations the effect might be favorable. In view of the difficulties, dangers, and great prolongation of these cases it is desirable that staphylococcic suppuration ensue upon the multiple incisions and it is justifiable to secure this by direct inoculation, or, better, by making multiple incisions and applying old-fashioned flaxseed poultices.

Acute Abscesses.—An acute abscess is a circumscribed cavity of new formation containing pus. We emphasize the fact that it is a circumscribed cavity—circumscribed by a mass of leukocytes and proliferating connective-tissue cells. A purulent infiltration is not circumscribed, hence it does not constitute an abscess. An essential part of the definition is the assertion that the pus is in a cavity of new formation, in an abnormal cavity; hence pus in a natural cavity (pleural, pericardial, synovial, or peritoneal) constitutes a purulent effusion, and not an abscess, unless it is encysted in these localities

by walls formed of inflammatory tissue.

An acute abscess is due to the deposition and multiplication of pyogenic bacteria in the tissues or in inflammatory exudates. These bacteria attack exudates or tissues, form irritants which cause inflammation or intensify existing inflammation, and by exerting a peptonizing action on intercellular substance and the fibrin of the exudate liquefy tissue and the products of inflammation, and form pus. As a rule, within twenty-four hours after lodgment of the bacteria the exudation increases in amount, the migrated leukocytes gather in enormous numbers, the fibers of tissues swell, and the connective-tissue spaces distend with cells and fluid. The connective-tissue cells, acted on by pus cocci, multiply by karyokinesis, develop many nuclei, lose their stellate projections, degenerate, and constitute one form of puscorpuscle, leukocytes forming the other. All the small vessels are choked with leukocytes, this blocking serving to cut off nourishment and tending to produce anemic necrosis. Liquefaction occurs at many foci of the inflammation, drops of pus being formed, the amount of each being progressively added to and many foci coalescing (Fig. 72). The pus-cavity is circumscribed, not by a secreting pyogenic membrane, but by a mass of fibroblasts, whose cells and intercellular material have not as yet broken down; such a mass of fibroblasts is often called embryonic tissue, and it is circumscribed by a zone of inflammation in which there are hordes of migrated leukocytes (Fig. 73). As an abscess increases in size, the embryonic tissue from within outward liquefies into pus, and the zone of inflammation beyond continually enlarges and forms more embryonic tissue. After a time the inflammation reaches the surface, the embryonic tissue glues the superficial to the deeper parts, the

superficial part inflames and becomes embryonic tissue, and the intercellular substance is liquefied. When pus has all but reached the surface, a thin layer of tissue only being undestroyed, an elevation or tit of thin tissue is formed, due to the fluid pressure. This process is known as *pointing*. The elevation or

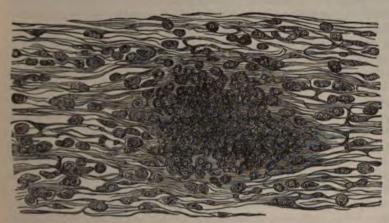


Fig. 72.—Infiltration of connective tissue of cutis (X 500) with beginning suppuration in the center (Senn).

point thins from tension and liqueiaction, and finally gives way and spontaneous evacuation occurs. When an abscess forms in an internal organ or in some structure which is not loose, like connective tissue,—for instance, in a lymphatic gland,—a mass of pyogenic bacteria, floating in the blood or lymph, lodges, and these bacteria by means of irritant products cause coagu-

lation necrosis of the adjacent tissue and inflammatory exudation around it. The area of coagulation necrosis becomes filled with white blood-cells, and the dry necrosed part is liquefied by the cocci. Suppuration in dense structures causes considerable masses of tissue to die and to be cast off, and these masses float in the Death of a mass with dissolution of its elements is necrosis, or inflammatory gangrene. Pus travels in the line of least resistance. It may reach a free surface, or may break into a cavity or joint, may invade bone or destroy a vessel. When an abscess ceases to spread or is evacuated, the fibroblastic layer forming the walls becomes vascularized and is con-



Fig. 73.—Diagram of an abscess: A, pus: B, layer of fibroblasts; C, tissue infiltrated with leukocytes; D, zone of stasis; E, zone of active hyperemia; F, healthy tissue.

verted into granulation tissue. An abscess heals by the collapse of its walls and fusion of the granulations (union by third intention), or by granulation (union by second intention). In either case granulation tissue is ultimately converted into fibrous or scar tissue.

Forms of Abscesses.—The following are the various forms of abscesses: Acute, which follows an acute inflammation. Strumous, cold, lymphatic, tuberculous, or chronic abscess is due to the bacilli of tuberculosis and does not contain true pus unless there is secondary pyogenic infection. It presents no signs of inflammation. A lymphatic abscess may form in a week or two, and hence is not necessarily chronic, which term is properly applied to a pyogenic infection of an infective granuloma. Caseous or cheesy abscess, a cavity containing thick cheesy masses, is due, perhaps to the fatty degeneration of inflammatory exudate and pus-corpuscles, but most commonly results from the caseation of a tuberculous focus. Circumscribed abscess is one limited by a layer of fibroblasts. Diffused abscess is an unlimited collection of pus, in reality not an abscess, but either a purulent effusion or a purulent infiltration. Congestive, gravitative, wandering, or hypostatic abscess is a collection of pus or tuberculous matter which travels from its formation-point and appears at some distant spot (as a psoas abscess). Critical or consecutive abscess is one which arises during an acute disease. Diathetic abscess finds its predisposing cause in a diathesis. Embolic abscess is due to an infected embolus. Tympanitic or emphysematous abscess is one which contains air or the gases of putrefaction. Encysted abscess, in which pus is circumscribed in a serous cavity. Fecal or stercoraceous abscess is one containing feces in consequence of a communication with the bowel. Follicular abscess is one arising in a follicle; hematic abscess, one arising around a blood-clot, as a suppurating hematoma; marginal abscess, which appears upon the margin of the anus. Pyemic or metastatic abscess is the embolic abscess of pyemia. Milk abscess is an abscess of the breast in a nursing woman. Ossifluent abscess arises from diseased bone. Psoas abscess is a tuberculous abscess arising from vertebral caries, the matter following the psoas muscle, and usually pointing in the groin. A sympathetic abscess, arising some distance from the exciting cause, such as a suppurating bubo from chancroid, is not in reality sympathetic, because infective material has been carried from the primary focus. Thecal abscess is a purulent effusion in a tendon-sheath. Tropical abscess is an abscess of the liver, so named because it occurs chiefly in those dwelling in tropical countries: it usually follows dysentery; urinary abscess, caused by extravasated urine. A verminous abscess is one which contains intestinal worms and communicates with the bowel. A syphilitic abscess occurs in the bones during tertiary syphilis, and is gummatous and not pyogenic. Brodie's abscess is a chronic abscess of the bone, most common in the head of the tibia. A superficial abscess occurs above the deep fascia; a deep abscess occurs below the deep fascia. A residual or Paget's abscess is a recurrence of active changes, it may be after years, around the residue of a former tuberculous abscess.

Symptoms of Acute Abscess.—In an acute abscess, as before stated, a part becomes inflamed and a quantity of fibroblasts are formed; fibroblastic tissue is liquefied (as above noted) and pus is produced. An acute abscess can occur in a person of any constitution.

Local Symptoms.—Locally there is intensification of inflammatory signs and enormous increase of the swelling. At first the area is hard, but afterwards becomes soft, and it finally fluctuates. The discoloration becomes dusky. The pain becomes throbbing and the sense of tension increases. The pain is greater the more dense the implicated tissue and the greater

the number of nerves it contains. At every pulse-beat the tension in the abscess increases temporarily, and hence the pain momentarily increases. Pain is increased by a dependent position of the part. There is great tenderness. The pain may be felt at the seat of suppuration or may be referred to some distant point. Tenderness is located at the focus of disease. The cutaneous surface, if the abscess is adjacent, is seen to be polished and edematous, and after a time pointing is observed and fluctuation can be detected. If pus is deeply situated the skin may not be reddened and perhaps the area of induration cannot be palpated. In such a case there is often rigidity of the muscles overlying the abscess (as in abdominal suppurations), the skin may be edematous (as in some cases of empyema), and besides local pain there may be pain due to pressure upon a nerve trunk, the pain perhaps being referred to a distant point.

Constitutional Symptoms.—If there is a small collection of pus in an unimportant structure there may be no obvious constitutional disturbance. If the abscess contains much pus or affects an important part, disturbances generally appear, from slight rigors or moderate fever to chills, high temperature, and drenching sweats. The constitutional condition typical of an abscess is due to the absorption of retained toxins, and is known as "suppurative fever," When an abscess is open but ill-drained, or when it is unopened and deep-seated, long-continued suppuration causes a fever which is markedly periodic: the temperature rises in the evening, attaining its highest point usually between 4 and 8 P. M., and sinks to normal or nearly normal in the early morning (from 4 to 8 A. M.). When the temperature begins to fall, profuse perspiration takes place. This fever is known as hectic. Prolonged suppuration causes albuminoid changes in various organs, notably in the liver, spleen, and kidneys. Albuminoid changes are especially common when there has been mixed infection of a tuberculous area and long-continued suppuration. It also occurs as a result of syphilis.

Dr. J. C. DaCosta, Jr., tells us ("Clinical Hematology") that "in both trivial and extensive pus foci the number of leukocytes may be normal or even subnormal; in the former instance because systemic reaction is not provoked, and in the latter because it is overpowered. Leukocytosis may also be absent in case toxic absorption is impossible, owing to the complete walling off of the abscess. In all other instances save these, a definite and usually well-marked leukocytosis occurs, amounting on the average to a count of about twice the mean normal standard, but frequently greatly exceeding this figure in the individual case."

The signs and symptoms of an abscess are somewhat modified by location, and it is wise to discuss acute abscesses in different situations.

Acute Abscesses in Various Regions.—Abscess of the brain may follow cerebral concussion or fracture of the skull may arise during a general infection but in about 50 per cent. of cases results from chronic suppurative disease of the middle ear. In abscess of a silent region of the brain symptoms may long be entirely absent. The usual symptoms are a temporary initial rise of temperature which soon gives place to a normal and in one-half of the cases to a subnormal temperature, headache, vomiting, delirium, drowsiness, and thoked disk. Localizing symptoms, spasmodic or paralytic, may be present. There is usually leukocytosis. In but few cases are there elevated tempera-

ture and sweats. Toward the end of the case there may be elevated temperature and delirium. In extradural abscess there is fever from beginning to end

(page 823).

Appendiceal or appendicular abscess results from inflammation, usually but not always with perforation of the vermiform appendix, plastic peritonitis leading to agglutination of the mesentery and omentum, adhesion of the bowels and mesentery, and the formation of a barrier of leukocytes and a mass of fibroblasts. This process circumscribes the pus. If the pus in suppurative appendicitis has been formed by colon bacilli or staphylococci, it will probably be circumscribed and limited. If the pus has been formed by streptococci, it will probably not be limited, and the peritoneum will be attacked by diffuse septic peritonitis. The signs of appendicular abscess are pain, tenderness, muscular rigidity, the existence of a mass, which may be palpated through the abdominal wall or rectum and which is dull on percussion, vomiting, sometimes constipation, and sometimes diarrhea. Very seldom is there skin edema and fluctuation. The patient lies upon his back, usually with one or both thighs flexed. In appendicular abscess there is fever, usually higher at night than in the morning, profuse sweating occurring during the fall. In some cases the temperature is peristently high. In some the elevation is trivial. In some chills occur. A sudden fall of temperature with shock is produced by rupture of the abscess-wall. If this accident happens, general peritonitis quickly arises. In appendicular abscess there is marked leukocytosis unless the walls are very thick or unless the process has diffused and general peritonitis has taken place, in which conditions it may be absent. Appendiceal abscess may be assumed to exist when the symptoms of appendicitis persist after the fifth or sixth day, or when, after the symptoms have subsided, they reappear a day or two later (page 088).

Abscess of the liver may not be announced by symptoms until rupture. It may follow dysentery, may be a result of the lodgment of infected clots from the hemorrhoidal veins, may follow upon the infective phlebitis of appendicitis, may result from septic cholangitis or suppuration of a hydatid cyst. We usually find fever of an intermittent type, profuse sweats, pain in the back, the right shoulder, or the right hypochondriac region, enlargement of the area of liver-dulness, also hepatic tenderness, and finally constitutional symptoms of the existence of pus. Sometimes there are fluctuation and skin edema over the liver, and the general cutaneous surface may be a little jaundiced. The symptoms vary as the pus invades adjacent organs. When there are pain on respiration and evidences of diaphragmatic pleuritis the pus is probably breaking into the pleural sac. There may or may not be leukocytosis (see page 1017).

Deep Abscess of the Neck.—The majority of these abscesses are due to suppuration of lymph glands, bacteria having reached the glands from an adjacent area of infection, cutaneous, mucous, or osseous. Suppuration beneath the deep fascia induces great pain and extensive swelling and often interference with respiration. The constitutional evidences of suppuration are noted. Acute suppuration under the deep fascia of the submaxillary region causes extensive inflammatory edema, interference with respiration and deglutition, violent constitutional symptoms, and often sloughing of tissues (see Ludwig's "Angina"). A deep abscess over the carotid artery is lifted

by each arterial beat and may be mistaken for aneurysm, but the pulsation is not expansible. The pus of a deep cervical abscess may track its way into the mediastinum or axilla or the abscess may break into a large blood-vessel, the pharynx, the wind-pipe or the gullet.

Axillary Abscess.—Superficial abscesses are usually multiple, are in reality furuncles, and result from infection of the sweat glands and hair follicles.

Deep abscesses are in most instances due to suppuration of the axillary lymph-glands. The most common cause is an infected wound or a focus of suppuration about the hand, forearm, arm or chest. An axillary abscess may result from caries of a rib or may follow a deep cervical abscess. An axillary abscess may be lifted at each beat of the artery and to this extent it resembles an ancurysm, but the pulsation is not expansile.

Acute retropharyngeal abscess is due to pyogenic infection of the retropharyngeal tissues. The abscess usually forms upon one of the lateral halves of the pharynx. It may be due to traumatism, to acute infectious diseases, to infective processes of the mucous membrane of the mouth, ear, and nasopharynx, or to pyogenic infection of a tuberculous abscess. In the great majority of cases the disease is due to suppuration of the deep cervical glands. There is pain, difficulty in swallowing, dyspnea, nasal voice, bulging into the pharynx, which is detected by inspection and palpation, enlargement of the deep cervical glands, fever, sweats, and great weakness. Tuberculous retropharyngeal abscess is considered on page 161.

Subphrenic or subdiaphragmatic abscess is apt to begin beneath the diaphragm, though in some few instances the pus forms above this muscle, and subsequently gains access to the region beneath. Such an abscess may contain not only pus, but gas, and in some cases also fluid from the stomach or intestine. The gas of a subphrenic abscess may have entered from a perforation of a hollow viscus or may have been made by gas-forming bacteria. Subphrenic abscess may arise after perforation of the bowel or stomach, or it may result from Pott's disease, perinephric abscess, traumatism, abscess of liver, kidney, spleen, or pancreas, empyema or pneumonia (Greig Smith). The symptoms are pain, fever, sweats, dyspnea, cough, and the physical signs of a collection of fluid beneath the diaphragm and often of gas in the cavity of the abscess. As in any other abscess there may or may not be leukocytosis (page 145).

Abscess of the lung gives the physical signs of a cavity; the expectoration is offensive and contains fragments of lung-tissue. An abscess may occasionally be located by the use of the x-rays. Pyemic abscesses may exist and yet escape discovery. (See Surgery of Respiratory Organs.)

Abscess of the mediastinum may arise secondary to deep abscess of the neck or vertebral suppuration; suppuration of the mediastinal glands, lung or pleura; taries of a rib or of the sternum, ulceration of the esophagus or pericarditis. It tauses throbbing retrosternal pain, pain in the back, chills, fever, sweats, irregular pulse, and often dyspnea. A lump may appear which pulsates and fuctuates, but the pulsation is not expansile.

Perinephric abscess usually causes tenderness and pain in the lumbar region or about the hip-joint, which pain runs down the thigh and is accompanied by retraction of the testicle. Induration, fluctuation, or edema of the skin may be observed in the lumbar region. The constitutional symptoms of suppuration usually exist (page 145).

Abscess or empyema of the antrum of Highmore is a collection of pus within the maxillary antrum. It results from inflammation of the jaws, the teeth or the mucous membrane of the nose. It causes pain, edematous swelling of the overlying soft parts, and crepitation on pressure upon the superior maxillary bone. Pus may escape from the nostril of the diseased side when the head is bent in the direction of the healthy side. A rhinoscopic examination discloses the fluid passing into the nares. The antrum on the side of the abscess cannot be transilluminated by an electric light in the mouth (Garel's sign).

The constitutional symptoms of suppuration usually arise.

Alveolar abscess is suppurative dental periostitis due to diseased teeth. The simplest form is a gum-boil, a collection of pus between the gum and the bone "external to the root of the tooth which is the seat of inflammation" ("Dental Surgery," by Sewill). In more severe cases the suppuration begins within the tooth socket and the pus escapes around the neck of the tooth, a distinct and local abscess may be situated at the end of the root, absorption of bone having occurred, or a considerable cavity may form in the bone, the external maxillary plate being perforated. In the very severe cases the cheek is involved. An alveolar abscess may break through the gum into the mouth or it may break externally through the cheek. Alveolar abscess causes intense pulsatile pain, marked swelling of the gum and cheek, and sometimes very great edematous and dusky swelling of the face. A sinus may follow its evacuation. Dead bone may form.

Abscess of the larynx invariably causes laryngeal edema which obstructs respiration and puts life in jeopardy. Such an abscess is most apt to appear upon the oral surface of the epiglottis but may arise within the larynx. It induces violent cough, pain, interference with the voice, swallowing, and breathing, and the swelling can often be felt with a finger and can always be

seen by the aid of a laryngoscope.

An ischiorectal abscess is situated in the areolar tissue of the ischiorectal fossa. The pyogenic organisms usually gain entrance to the lymphatics by way of an abrasion, fissure, or ulceration of the rectum or anus. A perforation made by a foreign body may inaugurate the condition. In rare cases bacteria reach the fossa in the blood-stream. The pain is severe and throbbing; there are great tenderness, redness and edema of skin, induration, and usually the constitutional symptoms of pus-formation. Fluctuation is a very late sign because of the density of the fascia.

Prostatic abscess may result from catheter infection, from infection of the bladder or urethra, or from traumatism, but the commonest cause is gonorrhea. There may be one abscess, several abscesses, or multiple abscesses. Pus may break into the rectum, the bladder, or the urethra or may break externally. A prostatic abscess is manifested by chills, fever, sweats, frequency of micturition, tenderness of the perineum and rectum, and agonizing pain, developing during an attack of acute prostitis. A finger in the rectum can palpate the swollen gland.

Abscess of the breast follows absorption of pyogenic bacteria from a fissure or abrasion of the nipple. Some surgeons maintain that the bacteria enter along the milk-ducts, while others assert that they gain entrance by the lymphatics. It is most common in nursing women. Its symptoms are swelling, tenderness, pulsatile pain, dusky discoloration, skin edema, fluctuation, and usually constitutional disorder. (See Mastitis.)

Orbital abscess is a diffuse suppuration due to cellulitis or a collection of pus due to caries or necrosis of the orbital wall, suppuration of the accessory nasal sinus, facial erysipelas, or dental caries. In severe orbital cellulitis the movements of the eye are limited, the lids are very red and edematous, the conjunctiva is red and swollen (chemosis), and, if the case is not promptly relieved, optic neuritis may arise and sloughing of the cornea occur.

Von Bezold's Abscess.—In this condition the pus of a suppurating mastoid process breaks through the mastoid near the tip and enters into the sheath of the digastric muscle or the sheath of the sternocleidomastoid. There exist extensive inflammatory swelling of the neck, a history of mastoid trouble, usually a lessened amount of pus from the ear, pain in the neck and constitutional symptoms. The condition suggests thrombosis of the lateral sinus, but the symptoms are not so violent and are not pyemic as they are in that disease.

Abscess of the Groin or Pyogenic Bubo.—Such an abscess may have mounted up from the pelvis, tracked forward from the sacro-iliac joint, or descended in the psoas sheath from the vertebræ, but in a very great majority of cases it is due to suppuration of the lymphatic glands. A bubo may be tuberculous, venereal or pyogenic. A pyogenic bubo results from an area of infection in the trajectory drained by the lymph-vessels of the inguinal or femoral glands. The glands involved may be superficial or deep. The symptoms are those ordinarily linked with suppuration. Occasionally the pulsations of the great ressels may lift the mass.

Abscess of the Popliteal Space.—This results from traumatism, mixed infection of a tuberculous or syphilitic area, suppuration of the contained lymph-glands of one of the adjacent bursæ or of the neighboring bone. In rare tases it arises as a result of suppuration of the sac of an aneurysm. The symptoms are severe pain, swelling, flexion of the knee, and edema of the leg. The pulsations of the popliteal artery may be transmitted to the abscess. These pulsations are not expansile, as in aneurysm. Pus may pass under the deep fascia up or down the extremity, or may break into the knee-joint.

Suppurative thecitis or jelon is a form of diffuse suppuration. (See Felon.) Palmar abscess is a purulent effusion (page 735).

Furuncle and carbuncle are discussed on pages 1222 and 1223.

Empyema is a purulent effusion into the pleural sac (page 890). It is technically an abscess if it becomes encapsuled.

Diagnosis.—The diagnosis of an abscess rests upon—(1) its history; (2) fluctuation; (3) pointing; (4) surface edema; (5) the use of the tubular exploring needle; and (6) leukocytosis.

Fluctuation is the sensation imparted to a finger held against a sac containing fluid when a wave is started in the fluid by striking the mass with a finger of the other hand. Fluctuation cannot be obtained if the amount of fluid is small. It should never be sought for across a limb, but rather along it, because a false sense of fluctuation can always be obtained across the muscles of the limb. Pointing and surface edema have been discussed.

A suspected abscess in a part containing large blood-vessels under no circumstance should be opened by a bistoury without knowing that the diagnosis is certainly correct. This knowledge is obtained in some cases by inserting 4 small aspirating needle and observing the nature of the fluid which exudes. This operation must be performed with aseptic care; otherwise, if there is no

abscess, infection may be inaugurated; if there is an abscess, mixed infection may occur. The older operators used a grooved exploring needle, but many able surgeons object to its use on the ground that when plunged into an infected area, pus bathes the track of penetration and may cause infection of other tissues and diffusion of the pyogenic process. The tubular exploring needle is the proper instrument.

An abscess which moves with the pulse because it rests upon an artery may be confounded with an aneurysm. The pulse movements of such an abscess are in one direction only; the abscess is lifted with each pulse-beat; but does not enlarge, and if a finger is laid upon either side of it the fingers will be lifted, but not separated. The pulse movements of an aneurysm are in all directions; they are expansile, the tumor grows larger, and the fingers will not only be lifted, but will also be separated. The small tubular exploring needle may be used in doubtful cases; if aseptic, it will do no harm even to an aneurysm. A rapidly growing, small-cell sarcoma feels not unlike an abscess, but the exploring needle discovers blood, and not pus. A cystic tumor is



Fig. 74.-Vischer's case for carrying culture-tubes for inoculation.

separated from an abscess by the absence of inflammation, or, if it inflames, by the nature of the contained fluid. Ordinary caution will prevent one confounding an abscess with strangulated hernia. A tuberculous abscess is separated from an acute abscess by the absence of inflammatory signs in the former. The contents of the acute abscess differ from those of the tuberculous abscess. When an abscess exists in an important region (brain, appendix, liver, etc.), cultures of the pus should be taken after incision. Such studies often give valuable information as to the probable course of the condition, and an accumulation of many accurate observations will add greatly to scientific information. Fig. 74 shows a convenient case for carrying culture-tubes.

**Prognosis.**—The prognosis varies according to the number of abscesses, their location and size, the strength of the patient, and the virulence of the causative bacteria.

Treatment.—In the treatment of an abscess there is one absolute rule which knows no exception, namely, that whenever and wherever pus is found

the abscess should be evacuated at once, and, after evacuating it, thorough drainage must be provided for. It should be opened early, if possible even before fluctuation and positively before pointing, to prevent tissue destruction, sub-fascial burrowing, and general contamination. Drainage is continued until the discharge becomes scanty, thin, and seropurulent.

Alveolar abscess requires prompt incision through the gum, extraction of the diseased tooth in most cases, and the rinsing of the mouth at frequent intervals with hot fluid. Heat should not be applied externally, as it would favor external rupture. If spontaneous rupture externally is inevitable, then an incision must be made at the point where the abscess is nearest the surface. The cut will leave less scar than will spontaneous evacuation. It is sometimes necessary to gouge a line through the external table of the bone,

pus being lodged within the two osseous plates.

Abscess of the liver, if the liver is adherent to the parietal peritoneum, is opened at one operation; if the liver is not adherent, the abscess is often operated upon in two stages. In the two-stage operation an incision is made along the edge of the ribs down to the liver, which organ is then stitched to the edges of the wound. In a day or two after the first operation the two layers of peritoneum are firmly adherent and the abscess can be opened without danger of the passage of pus into the peritoneal cavity. The abscess, located by an aspirating needle, is opened by the Paquelin cautery, is washed out with salt solution, and a tube is inserted. If care is taken the operation can be safely completed in one séance even if the liver is not adherent to the parietal peritoneum. If this course is determined on, after the liver is exposed by incision, the exposed surface of the organ is surrounded with iodoform gauze, the abscess is located by an aspirating needle, is opened by the cautery, is irrigated and drained as directed above. Some physicians try to locate an abscess by plunging an aspirating needle into the liver before making an incision. This procedure seems to me uncertain and dangerous.

Abscess of the dome of the liver may be reached by resecting a rib, incising the pleura, and opening through the diaphragm (transthoracic hep-

itotomy).

Abscess of the mediastinum, like all other abscesses, requires incision and drainage. This is effected, if the abscess can be reached from in front, by cutting between the rib cartilages or by trephining the sternum. Abscess of the posterior mediastinum can be reached only by resecting portions of several ribs near their vertebral ends.

In abscess of the lung an incision is made and the pleura is exposed. The incision is usually through an intercostal space; but if the spaces are narrow, it will be necessary to resect a rib. If the two layers of pleura are found adherent, the operation is proceeded with. If they are not adherent, they are slitched together with catgut sutures, and the surgeon waits forty-eight hours before continuing. This precaution is taken in order to prevent collapse of the lung from acute traumatic pneumothorax, during operation. The operation is completed by locating the pus by means of an aspirating needle, evacuating it by the cautery at a dull-red heat, and inserting a drainage-tube into the abscess-cavity.

A subphrenic abscess requires operation at once. Immediately before operating, if in doubt, it may be justifiable to endeavor to locate pus with an aspi-

rating needle. Incise the abscess and open any secondary abscesses. Many cases point below the diaphragm and are easily reached by an incision in the loin or in the epigastric region. Lannelonge resects the eleventh and twelfth ribs and raises the pleura out of the way. Some surgeons prefer to practice rib resection and incise the adherent pleural layers and the diaphragm. After drainage has been continued for a time it may be necessary to do a secondary operation in order to cure the lesion causative of the abscess, for instance, it may be necessary to close a gastric perforation.

In abscess of the antrum of Highmore bore a gimlet-hole through the superior maxillary bone, above the canine tooth, or perforate the bone by means of a trocar. Irrigate daily with boiled water or normal salt solution. Keep the opening from contracting by inserting a small tent of iodoform gauze. In persistent cases it may be necessary to draw a tooth, break through the socket of the first or second bicuspid into the antrum, and insert a silver or hard-rubber tube, and also to perforate the antrum from the inferior meatus and keep the opening patent. In very persistent cases osteoplastic resection of a portion of the upper jaw will be demanded.

In appendicular abscess incise, support the abscess-walls with gauze, remove the appendix in most cases, but not in all, and insert a drainage-tube

and strands of gauze (page 1000).

An ischiorectal abscess must be opened early. The surgeon never waits for fluctuation. Fluctuation is a very late symptom. To wait for it entails great destruction of tissue and serves no useful purpose. Place the patient on his side, with the legs drawn up. Insert a finger in the rectum, lift the abscess toward the surface, and incise it from the surface. The incision runs from the anal margin like a spoke from the hub of a wheel. Irrigate with salt solution, inject iodoform emulsion, insert a drainage-tube, dress, and let the patient know he is in danger of developing a fistula.

A retropharyngeal abscess must be opened early because delay may lead to fatal obstruction and because if spontaneous evacuation occurs the patient may be suffocated. Some surgeons open it from within the mouth, but this exposes the patient to the danger of septic bronchopneumonia from inhalation of purulent elements and to serious gastro-intestinal disorder from swallowing quantities of pus. Again, if opened through the mouth, the abscess is liable to become putrid. It is better to open it from the neck by Hilton's method, the incision being carried through the sternocleidomastoid muscle or posterior to it. Drainage is inserted and the abscess treated in the usual way.

In abscess of the breast make an incision radiating from the nipple, or, what is better, incise under the breast by means of a cut at the inferior thoracic mammary junction, and enter the abscess from beneath.

In abscess of the brain the skull should be trephined, the membranes incised,

and the abscess sought for, opened, and drained (page 821).

In suppuration within the *orbit* due to cellulitis, incise from the conjunctiva and drain. In suppuration due to caries or necrosis of the upper orbital wall make a transverse incision through the upper lid, reach the pus by Hilton's method (page 154), remove carious or loose necrotic bone, and drain.

A perinephric abscess requires an incision in the lumbar region and free

drainage.

An abscess of the larynx requires immediate scarification and inhalation of steam to abate swelling. In a severe case the surgeon should at once perform tracheotomy.

Bezold's abscess requires one or more incisions in the neck for drainage. Then the mastoid is exposed, its tip, including the osseous fistula, is removed, and its interior is cleared out by a complete operation.

A prostatic abscess should be opened promptly by a perineal incision.

In an ordinary superficial abscess, after cleansing the parts, make the skin tense, locate the superficial vessels and nerves, and plan the incision to avoid them. Incise with a sharp-pointed curved bistoury at the most dependent part of the abscess or through the region of pointing. If the abscess is upon the face or neck, make the incision in the line of the skin creases so as to limit the scar. The incision must not be made suddenly and fiercely, neither should it be made with hesitation and uncertainty. As Bryant says: "It should be done, as ought every other act of surgery, with confidence and decision, boldness and rapidity of action being governed by caution and made subservient to safety" (Bryant's "Practice of Surgery"). Permit the pus to run out spontaneously; pressure, as a rule, is undesirable because it may damage the abscess-wall and cause diffusion of the infection. If tissue shreds block the opening, they must be picked out with forceps. If the atmospheric pressure will not cause the pus to flow out, make light pressure with warm, moist, aseptic gauze pads. After the pus has come away gently wash the cavity with normal salt solution or boiled water, and drain with a tube for two or three days, when the discharge becomes serous. It is not desirable to overdistend the abscess-cavity with fluid, because the hydrostatic pressure might break down the wall of young cells and infection be diffused. Do not irrigate with powerful disinfectants. They cannot be used strong enough to really disinfeet, but may easily be used strong enough to cause necrosis of an abscesswall. Peroxid of hydrogen is not to be used unless the incision is large, because the gas it generates may tear the abscess-wall and diffuse the infection. Peroxid of hydrogen is a dangerous agent to inject into the cavity of a deep abscess of the neck, as the liberated gas may not escape from the opening, but may pass widely into the tissues and cause great distention. The author saw a child who narrowly escaped death after such an injection. In this patient the gas passed beneath the pharyngeal mucous membrane and the swelling almost occluded the air-passages. If an abscess contains putrid pus the incision should be free and after evacuation it should be irrigated with hot salt solution or peroxid of hydrogen and injected with iodoform emulsion. Pursue ngd antisepsis in dealing with purulent areas. It is true we already have infection with pyogenic bacteria, but infection can also take place with organof putrefaction, causing pus to become putrid, or with other bacteria, hir instance those of tetanus. If a tube is not used and the cavity is packed with fodoform gauze, remember that gauze will not drain pus and requires to be changed once a day or oftener. An abscess should be dressed with hot, moist antiseptic dressings (antiseptic fomentation) and the part must be put at rest. When the discharge becomes thin and scanty, dry aseptic or antiseptic dressings are used.

In a deep abscess or an abscess situated near important vessels, do not boldly plunge in a knife. Hilton says to "plunge in a knife is not courageous,

as it is without danger to the surgeon, but may be fatal to the patient." Remember also that a large amount of pus displaces normal anatomical relations. Hilton's method of opening a deep abscess (as in the axilla or neck) is to cut to the deep fascia, nick the fascia with a knife, and then push into the abscess a grooved director until pus shows in the groove; along the groove push a pair of closed dressing forceps; after they reach the depths take out the director, open the forceps, and withdraw them while open, and so dilate the opening; then insert a tube and gently irrigate with warm salt solution.

Always endeavor to open an abscess at its most dependent part, remembering that the situation of this part may depend upon whether the patient is to be erect or recumbent. If we do not make the opening at the lowest point, all the pus will not run out and the walls will not completely collapse. A deep abscess must be drained thoroughly until the discharge becomes seropurulent. When the tube is removed it is wise to insert a tent of iodoform gauze just through the outlet of the abscess. This tent prevents the skin from closing over the channel. It is removed and a new one inserted every day until it is clear that there is no longer danger of fluid becoming blocked and retained. When an abscess contains diverticula or pouches they should be slit up or a counter-opening ought to be made. A counter-opening is made by entering

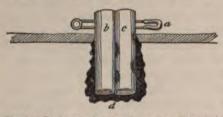


Fig. 75—Drainage-tubes for abscess requiring irrigation.

the dressing forceps at the first incision, pushing them through the abscess to the point where we wish to make our counter-opening, opening the blades, and cutting between them from without inward. The blades are then closed and projected through the incision; they are opened in order to dilate the new door, and are closed again

upon a drainage-tube, which is pulled through from opening to opening as the instrument is withdrawn. When pus burrows, insert a grooved director in each channel and slit the sinus with a knife. An abscess may make an opening through dense fascia, the opening being small like the neck of an hour-glass (shirt-stud abscess). Always examine to see if such a condition exists, and if it is found, incise the fascia.

In a deep abscess containing putrid pus, frequent irrigation is desirable. In such a case two tubes may be employed (Fig. 75). The tubes are prevented from slipping in by the use of a safety-pin (a). The irrigating fluid is passed into the cavity (d) through the tube b, which is without fenestra, and it runs out through the tube c, which possesses fenestra.

Rest is of the first importance in the healing of an abscess, and we try to obtain it by bandages, splints, and pressure, which will immobilize adjacent muscles and approximate the abscess-walls. If an abscess is slow to heal, use as a daily injection a solution of corrosive sublimate of the strength of 1:1000, or three drops of nitric acid to 3j of water, or 3 grains of zinc sulphate to 3j of water, or a 5 per cent. solution of carbolic acid, or a 2 per cent. aqueous solution of pyoktanin, or 20 drops of tincture of iodin to 3j of water, or a very dilute solution of bichlorid of palladium. The constitutional treatment of an abscess depends upon the severity of the morbid process and the importance

of the structures involved. In a serious case the patient should be put to bed, opiates should be given with a free hand, the bowels be kept active by calomel and salines, skin activity be maintained, the taking of nutritious food insisted on, and stimulants liberally employed.

Purulent Effusions.—(See Suppurative Thecitis, Palmar Abscess, Sup-

purative Synovitis, Purulent Peritonitis, Empyema, etc.)

Tuberculous Abscess.—The tuberculous abscess is called, also, the cold, the lymphatic, the congestive, the scrofulous, the strumous, the wandering, or the migrating abscess; and it is very commonly called the chronic abscess. The Germans call it Senkungsabscess. Tuberculous abscess is the best designation, as this indicates the cause of the trouble.

The term cold abscess is often used, because the cutaneous surface over the disease is not warmer to the touch than is the skin of the corresponding part of the opposite side of the body. The term lymphatic abscess was employed because it was once thought that such abscesses arose only from lymphatic structures. Scrofulous abscess was the name given it when scrofula was supposed to be a definite disease, the common phase of which was this form of abscess. The term chronic abscess is employed because the condition usually develops slowly, and does not present the evidences of acute inflammation; an acute pyogenic abscess developing, as a rule, rapidly, and presenting positive signs of inflammation. I agree with the late Professor Ashhurst that the term chronic, in this connection, is improper; as it tends to give a wrong idea. It refers merely to time; and we know that an acute pyogenic abscess that is deep-scated may be rather slow in developing, and that a tuberculous abscess that is superficial may develop with considerable rapidity. When used properly, the term chronic abscess means that genuine pus exists, this pus having arisen from the pyogenic infection of the granulation-tissue of a lesion of syph-Ilis, tuberculosis, or actinomycosis. In other words, a genuine chronic abscess secondary pyogenic infection of an infective granuloma. The terms wandering, migrating, gravitating, and congestive have been used because the fluid products of a tuberculous inflammation are liable to wander a considerable distance away from the primary focus of disease. For instance, a tuberculous abscess that is discovered in the groin may have arisen from tuberculous caries of the vertebræ. This tendency to wander is not due to gravity, as one of the names of the condition would suggest; but the wandering always takes place in the line of least resistance.

It will be seen from the foregoing that a true tuberculous abscess is not an abscess at all, because it does not contain genuine pus. It is a collection of the degenerated products of tuberculous inflammation; and a tuberculous abscess may be defined as a circumscribed cavity of new formation, containing the degenerated products of a tuberculous inflammation. These products may have been formed in that region or may have passed to that point from some adjacent or distant focus of tuberculous disease. If a supposed tuberculous abscess is found to contain genuine pus, there must have been mixed infection with pyogenic bacteria; and such mixed infection either causes violent and dangerous inflammation or leads to the formation of a true chronic abscess, in which there is no sign of acute inflammation. The tubercle bacillus is not pyogenic. It can produce inflammation, but not pus, and pus can be formed in a tuberculous focus only by secondary infection with pus bacteria.

Situations of Tuberculous Abscesses.—These abscesses are particularly apt to form as the result of tuberculous disease of bones, joints, lymph-glands, and subcutaneous connective tissue; but the brain, any viscus, or any tissue in the body may present the condition.

Age.—No age is exempt, but children are most prone to the trouble; and the period of greatest liability is before the age of twenty years.

Contents.—The usual term for the contents is scrofulous, curdy, or caseous pus. As I said, it is not trus pus; but it resembles pus when viewed with the naked eye. Examination of this fluid by staining methods, by cultures, and by inoculations shows that it contains no pyogenic bacteria. It consists of liquefied and caseated tubercle; masses of coagulated fibrin; and bits of necrotic tissue. The tuberculous material is whitish, vellowish, or yellowish-green; thick; and without odor. Floating in this pus are portions of caseous matter, which, as the elder Gross said, resemble bits of soft boiled rice. Occasionally the tuberculous material, especially if it comes from disease of a lymph-gland or of a bone, is almost watery and nearly colorless, and contains curd-like masses, consisting of tuberculous granulations, coagulated fibrin, and necrotic tissue. It was previously stated that tuberculous pus is free from odor. This is not true of tuberculous pus of the ischiorectal fossa, which is highly putrid; but in an ischiorectal abscess, as a matter of fact, there is usually mixed infection with pyogenic organisms, as well as with the organisms of putrefaction. If tuberculous pus is permitted to stand, the curdy mass settles to the bottom, and a thin serous fluid remains above.

Formation of Tuberculous Abscess.—During their growth, the tubercle bacilli in the tissues cause a chronic inflammation. The cells of the tissues, especially the fixed cells, proliferate and form granulation tissue. This granulation tissue consists of multitudes of cell clusters, and each cluster is called a primitive tubercle (page 229). Each individual tubercle enlarges; myriads of new ones form; and many of the old ones fuse. These new cells, however, do not become vascularized. In the earliest stage of their formation, there are blood-channels; but these become closed through endothelial proliferation and through the pressure of cells external to them. The tuberculous area then becomes absolutely avascular. This avascular mass of cells is composed of what are known as epithelioid cells, and the cells obtain nourishment by imbibition. The nourishment is very incomplete. As the nodule enlarges, the nourishment grows more and more insufficient. Finally, the adjacent blood-vessels that furnished the fluid for imbibition become occluded, and nourishment is no longer possible. The toxins of the tubercle bacilli, acting upon this area of greatly lowered nutritional activity, produce coagulation necrosis; and caseation follows this. The caseation begins at many points near the middle of the tuberculous nodule. Each area of caseation enlarges. Several of them fuse, and eventually many caseated areas coalesce. The tuberculous lesion may be spreading at the periphery at the same time that it is undergoing caseation at the center. The bacilli in the caseated material soon die for want of nourishment. When an area of caseated tubercle is liquefied by the addition of serum, what we call caseous or curdy pus is produced; and the lesion is then known as a tuberculous abscess.

The Wall of the Abscess.—The wall of the abscess is formed by compressed or solidified tissues. In a very recent case the wall is soft and will readily

collapse. In an old case it is dense or actually fibrous and will not collapse. This wall of compressed tissue is not, as used to be thought, a pyogenic membrane, which secretes the tuberculous material; but it actually surrounds the tuberculous material and hinders its diffusion. As Roswell Park says, it is not apyogenic membrane, but it is a prophylactic membrane. The inner surface of the wall of the compressed tissue is lined with tuberculous granulations, which at different points show different stages of the tuberculous lesion. This layer of tuberculous granulations is known as Volkmann's membrane. The fluid in the abscess may contain a few living bacteria, but often none can be found; and certainly the bacteria are not multiplying in this fluid, but they do multiply in Volkmann's membrane. When tuberculous matter has been long retained and thoroughly encapsulated the bacilli soon die for want of nourishment, and, because a culture from a supposed tuberculous area fails to show the bacilli of tuberculosis, we have not obtained conclusive evidence that the area is not tuberculous. We know this same fact to be true of the fluid of tuberculous empyema.

From the abscess-wall there may be one, two, several, or many sinuses tracking out. These sinuses are lines with granulation tissue exactly like the Volkmann's membrane in the main abscess; and they may spread by a sort of crawling progression for long distances, perhaps passing through dense fascia, and at their terminations form secondary tuberculous abscesses. The wall of an abscess may contain expansions or loculi. If an abscess spreads to some distant place, the tuberculous infection, of course, goes with it; and it is the tuberculous infection that causes the spread. The wandering of a tuberculous abscess is in the line of least resistance and is not the result of gravity. Injury, breaking, or contusion of this granulation tissue, if unaccompanied with the removal of all the tissue or the killing of all the germs it contains, may diffuse the pus and actually cause disseminated tuberculosis. We sometimes see such dissemination after spontaneous opening, non-aseptic operation, or forcible squeezing; and particularly after an imperfect operation that removes only a part of the tuberculous area.

Terminations of Tuberculous Abscess.—The abscess may slowly and gradually enlarge, and finally open of itself, either on the skin or on the mucous surface, or into some viscus or joint. It may become encapsulated by fibrous tissue, there being absorption of the fluid and shrinking of the entire focus, the caseous part perhaps remaining or becoming calcified. The tuberculous abscess may actually be replaced by fibrous tissue, and this constitutes a permanent cure. When the tuberculous area is merely encapsuled by fibrous tissue, some living bacilli may remain latent in the wall; and long afterwards, as the result of injury or of some other damage, an abscess may reform at the old site of disease. Sir James Paget calls this condition residual abscess, As a rule, the abscess, as it shrinks, tends toward cure. The bacilli usually die for want of material to nourish them; but occasionally they remain latent for a long period of time. When they do die, the tuberculous granulation tissue may become healthy tissue, be vascularized through the entrance of blood-vessels, and be converted into scar-tissue. Tuberculous abscess may also be cured by a surgical operation.

Secondary Infection of a Tuberculous Area with the Bacilli of Suppuration.—This is liable to occur when the abscess undergoes sponta-

neous evacuation, and may occur when it has been opened by the surgeon. It occasionally occurs when the abscess has neither undergone spontaneous evacuation nor has been opened by the surgeon, having been infected apparently as a point of least resistance. When such infection does occur, there is, in all probability, some area of ordinary suppuration elsewhere in the person's body; and the bacteria of suppuration have entered the body fluids. Pyogenic infection is apt to produce violent inflammation and profuse suppuration-a condition that is extremely dangerous, because septicemia is very liable to develop. In some very rare cases suppuration destroys the tuberculous area and cures the tuberculous disease. More commonly, however, it produces illness; and in large abscesses it may cause death. Because of this liability to secondary infection surgeons were long opposed to operating on tuberculous abscess unless it was evidently going to evacuate itself. cases, secondary infection produces a true chronic abscess (page 155). Infection with streptococci is much more dangerous than is infection with staphylococci. Acute inflammation with dangerous constitutional symptoms is particularly apt to arise: if the walls of the abscess contain very little tuberculous tissue, if they have been bruised or damaged with powerful chemicals; if there is poor drainage (and there is certain to be poor drainage if loculi exist, or when the incision is small and blocked with plugs of fibrin or necrotic tissue), if a partial or imperfect operation has been performed, if a number of virulent bacteria have been introduced, or if the vital resistance is at a low ebb.

Secondary Infection with the Bacteria of Putrefaction.—This complication is extremely grave and may produce death. It is commonly associated with pyogenic infection. The wound-fluid becomes intensely putrid, violent acute inflammation arises, and the absorption of materials from the wound induces the systemic condition known as sapremia or putrid intoxication.

Signs and Symptoms of Tuberculous Abscess.—A purely tuberculous abscess presents no evidence of inflammation, except swelling; and, owing to the absence of heat, it has received its name of cold abscess. The cutaneous surface looks and feels normal or is paler than normal until the structures just beneath the skin or the skin itself become involved. When this happens, livid discoloration appears; but the lividity presents a very different appearance from the dusky discoloration of an acute abscess. Neither is the skin edematous or glossy as it is in acute abscess.

There is rarely tenderness in the region of the abscess, and still more rarely spontaneous pain. Pain and tenderness, although frequently absent in the area of a tuberculous abscess, may be complained of at the primary focus of disease. Tenderness is especially likely to be noted at the primary focus; and in cases of joint-tuberculosis and of bone-tuberculosis, it is nearly always present. There may or may not be pain at the primary focus, but there is frequently referred pain. For instance, in tuberculous disease of the hip-joint the pain may be referred to the inner side of the knee; and severe belly-ache is frequently observed in Pott's disease of the spine. At the point to which pain is referred, however, there is no tenderness. For instance, in the belly-ache, particularly of Pott's disease of the spine, the belly is not tender although the spine is. In sacroiliac tuberculosis the disease is often referred to the distribution of the sciatic nerve; but the nerve is seldom tender on pressure.

In a psoas abscess we find that pain in the spine can be induced by pressing on the spinous process of the diseased vertebra, by concussion to the heels or the head when the spine is held stiff, and especially by flexion of the spine; but the spinal pain is lessened or completely abolished by extension, fixation, and rest. The primary focus of disease, if spinal or articular, produces rigidity in the adjacent muscles; and rigidity obtains rest by inhibiting movement, but it also impairs the function of the part. In an intra-abdominal tuberculous abscess, there is rigidity of the abdominal muscles.

In a tuberculous abscess fluctuation is usually obtained readily because the fluid is not surrounded by a thick mass of granulation tissue and also because a considerable amount of fluid is usually present. A notable characterstic of a tuberculous abscess is the tendency to wander, and it may appear with suddenness at some distant point. Abscesses of the spine wander long distances, but the wandering is not the effect of gravity and is due to the disposition of the tuberculous matter to travel in the line of least resistance. The temperature of the body may be entirely normal if the infection is purely tuberculous. As a rule, however, there is a slight evening elevation; and the patient is weak and pale, grows tired readily, sleeps poorly, and has a wretched appetite and impaired digestion. The blood examination sometimes, but not often, shows a notable diminution in the number of red blood-cells; but the hemoglobin is usually lowered to 60 or 70 per cent. There is no leukocytosis. In multiple tuberculous foci, and particularly in tuberculosis in children, there is a marked decrease in the red blood-cells. If secondary infection occurs, there is a rapid and progressive diminution in the number of these cells and usually leukocytosis.

A tuberculous abscess underneath the deeper fascia may break through the fascia by way of a small opening, and a large secondary abscess may arise in the subcutaneous tissue. The entire abscess is thus shaped like an hourglass, the opening through the fascia being the narrowest point. Such an abscess is called a *shirt-stud abscess*. A tuberculous abscess is liable to form one, several, or many sinuses; and the end of each sinus may expand into a secondary abscess. The surgeon must always make a careful examination to try to determine whether the abscess is the primary disease-focus or whether the tuberculous matter has wandered from a distant point. He must also make a thorough examination to see whether anywhere in the body there are other regions of disease. He will often find such areas; for instance, in the lungs. In many cases, however, there is no clinical evidence that other areas exist.

The tuberculous abscess usually requires weeks or months to reach the overlying skin or mucous membrane and undergo spontaneous evacuation. That spontaneous evacuation is imminent is shown by livid discoloration and thinning of the skin. Finally, at the area in which the skin is thinnest a little fit is elevated. This condition is known as pointing and a rupture occurs at this point, tuberculous pus running out. Spontaneous evacuation is a peril, because it is liable to be followed by secondary pyogenic or putrefactive infection. After spontaneous evacuation has occurred, a true chronic abscess may form; but there may instead be violent acute inflammation, manifested by pain, heat, and dusky discoloration. If acute inflammation does arise, there develops a fever, which presents evening exacerbations and morning remissions, and is accompanied by an exhausting sweat during the night or early morning. Fatal septicemia or sapremia may follow spontaneous evacuation.

Results of a Tuberculous Abscess.—It may undergo spontaneous cure, and the cure may be lasting; but long after an apparent cure, a new abscess may form (the residual abscess of Sir James Paget). A tuberculous abscess may remain stationary for a very long time, and then perhaps diminish in size and be cured, or extend in size and rupture. After spontaneous rupture, suppuration may cure the tuberculous area by annihilating the tuberculous tissue; but, as a rule, after spontaneous rupture there is either an acute septic process or a chronic suppuration, constituting a genuine *chronic* abscess.

The pyogenic infection of a tuberculous area, if it induces long-lasting suppuration, may lead to the development of albuminoid, amyloid, waxy or lardaceous disease in the middle and inner coats of blood-vessels, in connective tissue, lymphatic glands, the membrana propria of mucous membranes, the heart, the liver, the spleen, and the kidneys. The victim of albuminoid disease is pale, greatly exhausted and emaciated, and very anemic; suffers with diarrhea and usually has capillary hemorrhages beneath the skin and mucous membranes. The albuminoid material can be detected chemically in the urine, if the kidneys are involved. Albuminoid degeneration is incurable, and is usually fatal; but if the patient is subjected to proper treatment soon after it begins it may be arrested and not progress. The amyloid material is deposited between the cells and not in them. The disease is apt to arise in chronic tuberculosis with secondary pyogenic infection, especially in bone tuberculosis, but it may arise in syphilis, chronic suppuration in non-tuberculous subjects, and chronic dysentery. The albuminoid substance resembles fibrin and there are many theories as to its source. One theory is that the condition is due to the flow of pus removing potash salts from the blood, and thus leaving a dealkalinized blood-serum.

Diagnosis.—The fluctuation, the absence of evidences of acute inflammation, the tendency to wander, and, in some cases, the sudden appearance, mark the diagnosis. The surgeon always examines with care to see whether there is some distant tuberculous focus from which the abscess may have wandered, or whether the abscess itself is at the primary seat of disease. The advancing impairment of the general health, the lessened amount of hemoglobin, the normal or almost normal temperature, and the absence of leukocytosis are points in the diagnosis of the condition. In a doubtful case the aseptic use of the tubular exploring needle is important, the fluid that emerges being studied with the microscope after staining, by cultures, and perhaps by inoculating it into guinea-pigs. The fluid that is withdrawn may contain no bacteria that can be demonstrated; but if it is sterile and there are no pyogenic organisms, one should strongly suspect tuberculosis. Various diagnostic tests for tuberculosis will be found on pages 241–243.

Prognosis.—Advanced albuminoid degeneration gives a hopeless prognosis and any extent of albuminoid degeneration is unfavorable. Secondary pyogenic infection, as already stated, may produce death or a lingering suppuration. The prognosis is worse in very young children than in adults; and in any case it is unfavorable if the exhaustion deepens, if the anemia is marked, if there are tuberculous lesions in distant parts or in important organs or structures, if the patient is unable to take and digest food, and if the regions of tuberculosis cannot be extirpated or sterilized. Under other circumstances, the prognosis is favorable.

Tuberculous Abscesses in Various Regions.—Tuberculous abscess of the head of a bone (see Brodie's abscess, page 504) arises in the cancellous structure of a long bone, most often in the head of the tibia, and is frequently noted as having been preceded by a trivial traumatism. The focus of tuberculosis seldom induces severe symptoms unless secondary pyogenic infection occurs (page 230). A tuberculous nodule forms as a result of tuberculous osteomyelitis. The bone about the nodule is hyperemic, the bony trabeculæ are thickened, and the cancellous spaces "are devoid of fat cells, and they contain a swollen semi-fibrous material" (Warren's "Surg. Pathol."). The center of the nodule becomes cheesy, the bone trabeculæ are absorbed and the bone becomes cheesy and broken up, the cheesy mass containing bone fragments. Finally the area becomes filled with tuberculous pus, the cavity which



Fig. 76.—Case of cold abscess which had been treated as a hernia.

contains it being lined with tuberculous granulations. Distinct sequestra may form and the bone about the diseased focus undergoes sclerosis. In Brodie's abscess pain is continued but is not usually very severe, is of a boring character, and is worse when the patient is in bed. Attacks of synovitis arise from time to time in the adjacent joint. The bacteria of tuberculosis obtain access to the bone by means of the blood, and find in the bone a point of least resistance. There is no such thing as an acute abscess of bone. A pyogenic inflammation, of such severity that it would cause an acute abscess in soft parts, in bone causes acute necrosis.

Retropharyngeal or postpharyngeal abscess is often tuberculous. Such an abscess is usually due to caries of the cervical vertebræ, but can arise in the connective tissue of the parts or as a tuberculous adenitis. An abrasion of the mucous membrane may admit the bacilli to the connective tissue or the glands. A swelling projects from the posterior pharyngeal wall, and there is that interference with respiration and deglutition. Caseous matter from

caries of the cervical vertebræ may reach the posterior mediastinum by following the esophagus, or may appear in front of or behind the sternomastoid muscle in the neck (Edmund Owen). A tuberculous abscess in this region is apt to undergo pyogenic infection, in which case the patient develops fever, sweats, pain, and prostration.

Dorsal Abscess.—The tuberculous matter in dorsal abscess arises from dorsal caries, flows into the posterior mediastinum, and reaches the surface by passing between the transverse processes. The tuberculous matter from dorsal caries may run forward between the intercostal muscles or between these muscles and the pleura, pointing in an intercostal space, at the side of the sternum, or by the rectus muscle. It may burst into the gullet, windpipe,



Fig. 77.—Psoas abscess (Albert).

bronchus, pleural sac, or pericardium. It may descend to the diaphragm and travel under the inner arcuate ligament to form a psoas abscess, or under the outer arcuate ligament to form a lumbar abscess. A psoas abscess points external to the femoral vessels, a characteristic which distinguishes it at once from a femoral hernia.

Iliac abscess arises from lumbar caries, the swelling lying in the iliac fossa and pointing above Poupart's ligament.

Psoas abscess is usually due to lumbar caries, but may arise from dorsal caries. The fluid usually points in Scarpa's triangle external to the femoral vessels, but may descend much lower (Fig. 77). A psoas or iliac abscess, by following the lumbosacral cord and great sciatic nerve, forms a gluteal abscess. These abscesses may open into the bowel, bladder, ureter, or peritoneal cavity.

Lumbar Abscess.—In a lumbar abscess the fluid produced by dorsal caries descends beneath the outer arcuate ligament, or the fluid from lumbar caries which collected anterior to or in the quadratus lumborum muscle passes between the last rib and iliac crest in the triangle of Petit, the small space bounded by the crest of the ilium, the posterior edge of the external oblique muscle, and the anterior edge of the latissimus dorsi muscle.\*

Tuberculous abscess of the neck results from tuberculosis of the cervical glands. It is not often that such an abscess attains any considerable size. It tends strongly to spontaneous rupture, and, if this is permitted to occur, a livid, corrugated scar results.

Tuberculous abscesses of joints (see Chapter XIX).

Tuberculous Abscess of Rib.—It is not uncommon to find a tuberculous abscess of moderate size about a tuberculous rib. The pleura may become involved secondarily.

Tuberculous mediastinal abscess may result from the downward

\*For a lucid description of these abscesses see Owen's "Manual of Anatomy," from which much of the above is condensed.

passage of a cervical abscess; from tuberculosis of the sternum, ribs, vertebraor pleura, or from tuberculous mediastinal glands.

Tuberculous abscess of the breast is a caseated and liquefied area of tuberculosis of the breast. A lump is detected, which slowly enlarges and finally ruptures, sinuses being formed. The axillary glands are apt to be implicated. The patient may belong to a tuberculous stock, as a rule gives a history of previous tuberculous troubles of various sorts, and has usually borne children. Chronic abscess of the breast causes little or no pain.

Treatment of Tuberculous Abscess.—For many years the majority of surgeons would not operate upon a tuberculous abscess unless it was on the point of rupturing. With the advent of antiseptic surgery, it was assumed that aseptic incision and drainage would be the proper treatment for these cases; but the results, except in small superficial tuberculous abscesses, have been extremely disappointing. If a large abscess is so treated, pyogenic infection will, in all probability, sooner or later occur, with all its possibilities of disaster. Incision and drainage is, therefore, restricted to small and superficial abscesses.

Treatment of Small Superficial Tuberculous Abscesses.—The surgeon must remember that after one has opened an apparently superficial abscess it is his duty to make an examination to see that there is no channel connecting the abscess with a deep or a distant focus. If he finds such a channel, he may be disposed to follow one of the plans of treatment outlined on pages 163 and 164. It is also his duty to see whether there are sinuses tracking off from the abscess; and if these exist, he must slit them up. If there are loculi in the wall of the abscess, he must stretch their mouths. He must be particularly careful to see that he is not dealing with a shirt-stud abscess, in which there is a little opening through the deep fascia connecting the abscess above with the abscess below. In a shirt-stud abscess the deep fascia must be freely incised. After the abscess has emptied itself, its walls must be thoroughly scraped with a curet, and the cavity must be drained with a tube or, preferably, packed with iodoform gauze. If the skin above a superficial abscess is diseased and discolored, and the abscess is on the eve of spontaneous rupture or has ruptured, the discolored skin must be cut away with scissors. If the discolored skin is allowed to remain, a livid and jagged scar will inevitably result. If it is cut away, a healthy scar, not very deforming, will result.

Treatment of Tuberculous Abscesses of Considerable Size.—Method I. Aspiration, Irrigation, and the Introduction of Iodoform.—The operation is carried out with the most scrupulous aseptic care. The trocar is passed through the sound skin; is carried beneath the skin for an inch, as Senn suggests; and is then made to enter into the cavity of the abscess. The stylet is pulled out, and the flow of fluid is aided with very delicate pressure. Occasionally the tube will become blocked by necrosed tissue or plugs of fibrin. It is opened up again by pushing in a wire or forcing in a stream of sterile fluid. When tuberculous matter ceases to run out of the trocar, a very warm solution of boracic acid is thrown in in order to wash the abscess-walls. This can be inserted with a fountain syringe or with the special apparatus of Senn (Fig. 78). Enough of it is allowed to enter to overdistend the abscess-cavity, as Mr. Callender long ago advised. The fluid is then allowed to pass out; fresh fluid is passed in; and this procedure is repeated, perhaps again and again, until entirely the fluid flows out. When this takes place, an emulsion of iodoform is thrown

in by Senn's syringe. A 10 per cent. emulsion in glycerin is as satisfactory as the more elaborate formulas. Verneuil used to employ iodoform and ether; but this is painful, is more liable to cause iodoform-poisoning, and sometimes induces gaseous distention and ruptures the wall of the abscess. In order to prevent the danger of iodoform-poisoning the surgeon should not introduce at one time more than eight drams of the emulsion, if dealing with an adult;

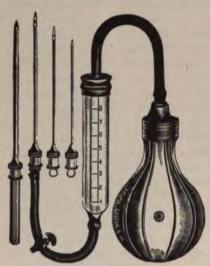


Fig. 78.—Senn's injection syringe.

or more than four drams, if dealing with a child. After the emulsion has been inserted into the abscess-cavity, the wound in the skin is sealed with a bit of gauze and iodoform collodion. Gauze is fluffed up and laid on the skin above the abscess, and the walls of the cavity are then forced toward each other by applying a roller bandage. The part is put at complete rest, and it is usually necessary to put the patient in bed. Sometimes, although very seldom, one injection will produce a cure; but usually, after one or two weeks, it will be observed that the cavity has to some extent filled again. A second operation is then performed; and, if improvement is really taking place, it will be found that the fluid is not nearly so thin as

it was at the first operation. It is needless to persist in this method after six or seven attempts have failed to cure. If the abscess has thick and uncollapsed walls, it is not fitted for treatment by aspiration and injection.

Method 2. Incision, Cleansing, and Suture.—If, owing to the considerable size or the rather rigid walls of the abscess, one believes that the aspiration method would be useless; or if the aspiration method has been tried and has failed, one may adopt the following plan. It should not, however, be employed, if the walls are very thick and rigid. An incision is made at the most dependent part of the abscess. The walls are scraped carefully with Barker's sharp-edged irrigating curet (Fig. 79), and are rubbed smooth with bits of



Fig. 79.—Barker's sharp-edged irrigating curet (Keen's Surgery).

gauze. The part is freely irrigated with hot boracic acid solution, and pressure is applied to arrest bleeding. Iodoform emulsion is introduced; the skin is sutured; dressings, compresses, and bandages are applied; and complete rest

is secured. This operation may cure an abscess; or it may be necessary to

repeat the procedure two or three weeks, or many weeks, afterward.

Method 3. Incision and Removal of the Primary Focus of Tuberculosis .- If one has not used the iodoform treatment, or if it has failed and if one finds that the primary seat of disease may be attacked and removed, an operation should beundertaken to get rid of Volkmann's membrane in the last-formed abscess and also to remove the primary tuberculous focus. An incision is made, when possible, that will lay open not only the last-formed abscess, but the primary lesion. Tuberculous tissue is thoroughly removed with Barker's spoon and by rubbing with gauze, or, perhaps, by scissors and forceps. Any focus of bone disease is curetted and touched with pure carbolic acid, and loose fragments of bone are removed. The part is irrigated with a hot solution of botacic acid; bleeding is arrested by pressure; and the wound is nearly, but not quite, closed, drainage being inserted at the most appropriate spot. Dressings, compresses, and bandages are then applied. In this operation, the enfire tuberculous area has been removed, and the raw surfaces have been forced into contact; and there is no more danger of secondary pyogenic infection than there is in any ordinary wound.

General Treatment.—It is never to be lost sight of that in every case of tuberculous abscess the general treatment of tuberculosis must be rigorously pursued (see page 245). In the treatment of a cold abscess give nutritious food, cod-liver oil, quinin, iron, and the mineral acids. Removal to the seaside is often indicated, life in the open air is imperative, and mechanical appli-

ances may be needed for diseases of the bones and joints.

Chronic Abscess of Bone.—Make an incision to bare the bone. Open the abscess with the trephine, the gouge, or the chisel; curet interior of the wall of the cavity with a sharp spoon and rub it with bits of gauze; cut away the edges of the bone with rongeur forceps; irrigate the cavity with hot normal salt solution, dry its walls with gauze, and paint the cavity with pure carbolic acid; pack with iodoform gauze and apply antiseptic dressings. It is better not to employ an Esmarch apparatus. Bleeding will not be severe, and when no apparatus is used to prevent bleeding one can be sure that all the diseased bone has been removed, because sound bone bleeds and dead bone does not.

Cold Abscess of Lymphatic Glands.—In non-exposed portions of the body the capsule of the gland should be incised and dissected or scraped away and the cavity swabbed out with pure carbolic acid or iodin and packed with iodoform gauze, but drainage should not be prolonged. If the abscess is allowed to burst, it will cause an ugly scar; therefore, in exposed portions of the body, as the neck, special effort should be made to prevent a scar by incising carly before the skin is involved. When only a little caseated matter exists and the skin is not discolored, prepare the parts antiseptically, incise, rub the interior with gauze, inject iodoform emulsion, and suture the wound. It used to be a custom in such cases to carry a silk thread by means of a needle through the skin, through the gland, and out at its lowest point, the part being then thrested with gauze. In three days the thread was removed and a firm compress was applied. The plan is not satisfactory and incision is to be preferred. When the gland is almost entirely broken down and the skin above it is becoming purple and thin, insert a hypodermatic needle through sound skin into the

abscess, draw off the fluid tuberculous matter, and inject iodoform emulsion. This procedure is to be repeated when the fluid again accumulates. By this means we can sometimes effect a cure in a week or so. When an abscess breaks or is on the point of breaking, cut away all purple skin, curet the abscess-walls (the abscess having become a tuberculous ulcer), remove the remains of gland and capsule, swab the cavity with pure carbolic acid, and dress with iodoform and antiseptic gauze.

Tuberculous glands ought to be extirpated before they caseate and form an abscess. If an abscess does form it is treated as is directed above and after healing takes place the diseased glands are extirpated. If sinuses exist they are curetted and touched with iodin or carbolic acid. After healing, the glands are extirpated. When sinuses exist there is always mixed infection.

Tuberculous Abscess of a Rib.—This lesion requires incision of the soft parts and resection of the diseased bone. The tuberculous area is thoroughly curetted, rubbed with pure carbolic acid, and packed with iodoform gauze.

Tuberculous Mediastinal Abscess.—In tuberculous abscess of the mediastinum aspiration and injection of iodoform may prove efficient. In some

cases it will be necessary to open and drain.

Cold Abscess of the Mammary Gland.—Many operators simply incise, curet, pack with iodoform gauze, and dress antiseptically. It is wiser to remove the entire gland, and to clear out the axilla, as in an operation for cancer, in order to prevent both recurrence and dissemination.

Large Cold Abscesses.-In view of the facts that these abscesses may cause no trouble for years and that an operation may be fatal, some eminent surgeons are opposed to an operation unless the abscess is moving toward inevitable rupture or is disturbing the functions of organs by pressure. Most practitioners believe, however, and I agree with them, that this mass of tuberculous matter is a source of danger through being a depot of infective organisms which may overwhelm the system, and that death will seldom result from an operation performed by one who employs with intelligence strict antisepsis. In no other cases is attention to every detail more important, as a mixed infection may easily take place, and will probably mean death. As W. Watson Cheyne points out, over seventy per cent. of cases of spinal abscess treated by aseptic methods recover completely and without any real illness after such an operation. The recoveries from the old letalone method will be infinitely less than this, and cases cured by operation usually remain well. The surgeon must always remember that the wall of the abscess and not the fluid in the cavity is the real seat of disease, and this wall must be actually removed or completely sterilized if operation is to be safe. To simply open, drain, and leave the wall to Nature to get rid of if she can is fraught with the gravest peril.

Psoas Abscess.—Some of these cases can be treated by aspiration and injection (page 163), others by incision and subsequent suture (page 164), others by the radical operation set forth on page 165.

Treves's operation for psoas abscess is described on page 707.

An operation occasionally performed for psoas abscess consists in an incision in the groin, an incision in the back, removal of carious vertebræ, thorough cleansing of the abscess-wall, and through-and-through tubular

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drainage. It has been found, however, that this operation is uncertain and dangerous. It is not advisable to remove carious vertebræ, and through-and-through tubular drainage is rarely used unless mixed infection already exists. When a large abscess breaks spontaneously, it should be widely opened at once, scraped and irrigated, rubbed with gauze, swabbed with pure carbolic acid, washed out with alcohol, and packed with iodoform gauze. If secondary pyogenic infection of a large tuberculous abscess does occur, the patient will develop septic fever and will probably die (q, v).

Dorsal abscess and lumbar abscess are treated after the same plan as

traveled to a distant point.

A postpharyngeal abscess must not be opened through the mouth. To open it in this manner puts the patient in danger of suffocation by fluid running into the larynx during or after the operation. Further, mixed infection of the abscess-area will be certain to ensue. Septic pneumonia will be apt to arise from inhaled infected particles, and profound gastro-intestinal disturbance will be liable to develop because of the inevitable swallowing of purulent, putrid, and tuberculous masses. Incise the neck and open into the abscess by Hilton's method, going through the sternocleidomastoid muscle or behind it. Rub the wall of the abscess with bits of gauze, remove any loose bone, irrigate with hot normal salt solution, inject iodoform emulsion, insert a tube or pack with iodoform gauze.

## VII. ULCERATION AND FISTULA.

An ulcer is a loss of substance due to molecular death of a superficial structure. The molecular death is brought about by bacteria. Ordinary ulcers are caused by pus organisms. The action of the pus organisms is the same as in an abscess. A broken abscess becomes an ulcer, and an ulcer is in structure a half-section of an abscess. The floor of an ulcer consists of granulation tissue and corresponds with the abscess-wall. An abscess arises from molecular death within the tissues; an ulcer, from molecular death of a free surface. An ulcer may increase in size by molecular death of adjacent structures or by sloughing, that is to say, by death of visible masses of tissue. A wound healing by granulation is often wrongly called an ulcer. An ulcer must not be confounded with an excoriation. In an ulcer the corium is always, and the subcutaneous tissue is generally, destroyed, and a scar is left after healing. In an excoriation the mucous layer of epithelium is exposed, or this is destroyed and the corium is exposed. In an excoriation the conum is never destroyed, and no scar remains after healing. An ulcer heals by granulation (page 123). Embryonic tissue by vascularization becomes granulation tissue, granulation tissue is converted into fibrous tissue, the fibrous tissue contracts, and by pulling the edges of the ulcer toward each other lessens the size of the cavity. When the granulations reach the level of the skin the epithelium at the edges of the ulcer proliferates and the sore is soon covered over with new epithelium.

Necrosis of a superficial part may arise from—(1) Inflammation. The pressure of the exudate can cut off the circulation, or bacteria may directly

destroy tissue. Suppuration occurs. (2) The action of pus bacteria, causing primary cell-necrosis. (3) Bacteria of putrefaction and organisms of suppuration acting upon a wound. (4) Traumatism or irritants, producing at once stasis, which is added to by secondary inflammation, the exudate undergoing purulent liquefaction. (5) Prolonged pressure. (6) Deficient blood-supply. (7) Faulty venous return. (8) Degeneration of a neoplastic infiltration (gummatous, malignant, or tuberculous). (9) Trophic disturbance. (10) Nutritional disturbances (as scurvy). Most ulcers are due to pus organisms, and even areas of necrosis that arise from something else (as gummatous

degeneration) are likely to suppurate.

Classification.-Ulcers are classified into groups according to the condition of the ulcer and the associated constitutional state. In the first group we find the varicose, hemorrhagic, acute, chronic, irritable, neuralgic, etc. In the second group are placed the tuberculous, syphilitic, senile, scorbutic, etc. All ulcers, whatever their origin, are either acute or chronic, and such conditions as great pain, hemorrhage, edema, exuberant granulations, phagedena, sloughing, eczema, gout, syphilis, scurvy, etc., are to be looked upon as complications. The leg is so common a site of ulcers as to warrant a special description of ulcers of this part. In describing an ulcer state the patient's previous history; the supposed cause; the situation; the outline; the duration; and the mode of onset of the ulcer. State if the ulcer is single or if multiple sores exist, and if there is or is not pain; whether or not any healing has ever occurred, and the patient's constitutional condition. Set forth the complications; the state of anatomically related glands; the condition of the edge, the floor, and the parts about the ulcer, and the nature and quantity of the discharge.

Acute or inflamed ulcer of the leg may follow an acute inflammation and may be acute from the start, or may be first chronic and then become acute. It is especially common in drunkards, and among those of dilapidated constitutions. It is characterized by rapid progress and intense inflammation. There is rarely more than one ulcer. In outline these ulcers are usually oval, but may be irregular. The floor of an acute ulcer contains no granulations, but is composed of the raw and inflamed tissues, or is covered with a mass of gray aplastic lymph, or it may have upon it large greenish sloughs. The edges are thin and undermined. The discharge is very profuse and ichorous, excoriating the surrounding parts. The adjacent cutaneous surface is inflamed and edematous, and there is much burning pain. In some cases the glands in the groin enlarge. Constitutionally, there is gastro-intestinal derangement, but rarely fever. When the ulcer spreads with great rapidity and becomes deeper as well as larger in surface area, it is called "phagedenic." The formation of sloughs indicates that tissue death is going on so rapidly that the dead portions have not time to break down and be cast off. Limited stasis produces molecular death; more extensive stasis, a slough. If a chronic ulcer becomes acute, the granulations are destroyed.

Treatment.—In treating an acute ulcer of the leg, give a dose of blue mass or calomel, followed in eight or ten hours by a saline (3ij each of Rochelle and Epsom salts), and order light diet. Deny stimulants except in a case of diphtheritic ulcer. Administer opium if pain is severe. Spray the ulcer with hydrogen peroxid, use the scissors and forceps to get rid of sloughs, and

after sloughs are removed wash the ulcer with corrosive sublimate solution (1:1000), or paint it with pure carbolic acid. Paint the skin adjacent to the ulcer with equal parts of tincture of iodin and alcohol. Dress with hot antiseptic fomentations. Apply a bandage from the toes to well above the ulcer. Insist on the patient remaining in bed with the leg slightly elevated. Change the dressings before they become cool and always as soon as they are saturated with discharge. Every day paint the parts about the ulcer with equal parts of iodin and alcohol.

Many cases do very well after antiseptization, and dusting the ulcer with iodolorm, lead-water and laudanum being applied to the inflamed parts around the ulcer; but in a bad case hot antiseptic fomentations, compression, and elevation are more useful until sloughs separate. If the discharge is offensive, apply acetanilid, aristol, or iodoform, or use gr. iij of chloral to 3j of water, before applying hot fomentations or ordinary antiseptic dressings. A 25 per cent. ointment of ichthyol is very useful when applied to parts around the ulcer. If sloughs continue to form, touch the sloughing area with a 1:8 solution of acid nitrate of mercury or with a solution of pure carbolic acid, and reapply antiseptic fomentations. If an ulcer continues to spread, clean with peroxid of hydrogen, dry with absorbent cotton, touch with nitrate of mercury solution (1:8), and apply an antiseptic fomentation. Repeat application of nitrate of mercury every day until the ulcer ceases to extend and granulations begin to form. When granulations begin to form moist hot dressings are no longer necessary, and dry aseptic or antiseptic dressings can be used.

If an ulcer is covered with a great mass of aplastic lymph, touch daily with a solution of silver nitrate (gr. xl to 3j) or with acid nitrate of mercury (1:15), and dress with iodoform and antiseptic fomentations. Give internally tonics, stimulants, and nutritious liquid food. In any case, when granulations form, dress antiseptically with dry dressings, or employ a non-irritant ointment, such cosmolin. If granulations form slowly touch them every day with a solution silver nitrate (gr. x to 3j) and dress antiseptically, or apply a stimulating circument (resin cerate or 3j of ung. hydrarg. nitratis to 3vij of ung. petrolii, an ointment of copper sulphate, gr. iij to 3j), or dress with gauze soaked

a solution of 3 drops of nitric acid to 3j of gum Arabic.

Chronic ulcer of the leg is characterized by low action and slow prog-It may be chronic from the start, or it may result from acute ulcer. Usually it is found as a solitary ulcer two inches above the internal malleolus. Syphilitic ulcers often occur in a group, are usually crescentic, and Fe frequent upon the front of knee. A tuberculous ulcer may have no granu-Lations, but is usually covered with pale edematous granulations, which signify the existence of a tendency to venous stasis. The edges of the tuberculous ulcer are undermined and irregular, the parts about it are livid and tender, and the discharge is thin and scanty (page 250). An ordinary chronic ulcer circular or oval, and is surrounded by congested, discolored, and indurated skin, this induration being due to fibrous tissue, and there is often eczema or a brown pigmentation of the neighboring skin. The floor of the ulcer is uneven, and usually is covered with granulations, each of which is red and the size of Pin-point, but which may be exuberant or edematous. If granulations are absent, the ulcer has the appearance of a piece of liver, or is smooth and Blazed. The edges are thick, turned out, and not sensitive to the touch.

Occasionally, but rarely, they are thin and undermined. Some ulcers are indurated and adherent; this adhesion to the deeper structures prevents healing by antagonizing contraction. An ulcer may fail to heal because of severe infection; because of want of rest; because of absence of granulations resulting from deficient blood-supply; because of edematous granulations; because of exuberant granulations; because of adhesion to deep structures, or because of some constitutional disease.

Treatment.—In treating a chronic ulcer, give a saline cathartic every day or so. Treat any existing diathesis. Insist on rest and, if possible, elevation. Asepticize the ulcer. Draw blood by shallow scarifications of the



Fig. 80 .- Incisions for adherent ulcer.

bottom and edges of the ulcer and the skin about it. If the ulcer is adherent to deeper structures, make incisions like those shown in Fig. 80, each cut going through the deep fascia. These incisions, besides permitting contraction, allow granulations to sprout in the cuts and absorb exudate. Nussbaum advocated encircling the ulcer with an incision about

one-half or two-thirds of an inch away from the edge of the ulcer, the incision passing through the skin. After incision keep the part elevated and dressed antiseptically for two days. In two days after scarification or incision scrape the ulcer with a curet until sound tissue is reached. Use hot antiseptic fomentations for two days more, then paint the parts adjacent to the ulcer with tincture of iodin and alcohol (1:3), dress the parts about the ulcer with ichthyol ointment, and dress the ulcer antiseptically or with sterile gauze. In a day or so the use of ichthyol should be discontinued and the ulcer be dressed with sterile gauze, normal salt solution, boric acid, bichlorid of palladium, chlorin-water, a solution of permanganate of potassium, sulphur, glutol, protonuclein, or bovinin. Glutol (formalingelatin) is very useful in some cases and so is protonuclein. When healing begins, treat as outlined for healing acute ulcer (page 168). Many cases can be cured by baking in the hot-air apparatus for half an hour to an hour daily. A moderate heat is indicated and in the intervals of treatment an elastic bandage should be used and if possible the patient should be kept in bed.

Unna's dressing is satisfactory in many cases. It is applied as a fluid, painted on when hot. It solidifies on cooling and resembles rubber. The paint is made as follows: Dissolve 4 parts of the best gelatin in 10 parts of water by means of a hot-water bath. While the fluid is hot add 10 parts of glycerin, and then 4 parts of powdered white oxid of zinc and stir energetically until the mixture is cold. Melt the paint before using by placing the receptacle in a hot-water bath. The extremity must be clean and thoroughly dry. Apply the paint from just above the roots of the toes to just below the knee. Cover the layer of paint with a gauze bandage; put over this another layer of paint, then another bandage, and so on until three, four, or five bandages have been applied. To prevent wrinkling, put the bandages on in pieces. The outer layer of the dressing is a coat of the paint. This dressing is worn from four to eight weeks unless it loosens sooner. When it loosens, it is changed. If the ulcer discharges freely and stains the dressing, cut a trap-door in the

dressing and through this cleanse the ulcer and apply dressings and a bandage as often as necessary (Michel, in "Chicago Clinic," No. 8, 1900).

An excellent treatment if the patient must walk about is camphor, first recommended by Schulze ("Münchener medicinische Wochenschrift," March 19, 1901). It is most conveniently used, as Walbaum shows, in the form of spirits of camphor ("Münchener medicinische Wochenschrift," June 25, 1901). He applies the dressing in the following manner: Clean the ulcer with green soap and dress it daily with dressings wet with a 2 per cent. solution of the acetate of aluminium. In about three days the discharge will become scanty and free from odor. It is at this period that camphor should be used. A small piece of gauze wet with spirits of camphor is applied directly and only to the ulcer. Over this is applied a large piece of dry sterile gauze, a rubber dam, a large piece of absorbent cotton, and a bandage from the toes up. Every other day the dressings are removed, the ulcer is washed with a 2 per cent. solution of carbolic acid, and the dressings are reapplied. Usually the ulcer is healed in three weeks.

Complications.—Remove by scissors and forceps any badly damaged tissue. Take out dead bone; slit sinuses; trim overhanging edges. Treat eczema locally by washing with ethereal soap and applying powdered oxid of zinc or borated talcum, the leg then being wrapped in cotton. Unna's paint is very useful in chronic eczema. If the part is crusted, the crusts should be removed by applying some oily materials and washing with ethereal soap and water. Ordinary soap should not be used. In an acute case soap and water always do harm and the part is to be cleaned by "gently wiping with cold cream or petrolatum" (Stelwagon, on "Diseases of the Skin"). If crusting is very marked it may be necessary to remove it by means of an ordinary poultice, or, better, a starch poultice made with a 2 per cent. solution of boracic acid. When scales or crusts are slight or absent or when they have been removed, the remedial agent should be applied. The remedies for eczema are legion. Among them are a solution of lead acetate; lead-water and laudanum; a powder composed of 30 grains of powdered boracic acid and ounce each of tale and zine oxid; ung. picis liquidæ, 3j, with sufficient ung. zinci oxidi to make 3j; 1 ounce of liquor carbonis detergens to 1 pint of water. In every case of eczema place the patient upon a plain and nutritious diet; order him to avoid wines and liquors; give an occasional saline arative; keep the skin and kidneys active, and if the patient is gouty or rheumatic, give appropriate remedies. The value of arsenic in eczema has been much overrated.

Varicose veins demand either ligation at several points, excision, Trendelenburg's operation (page 461), circumcision by Schede's method (page 461), or the continued use of a flannel roller or a Martin rubber bandage. Never operate on varicose veins if phlebitis exists unless a clot has formed, in which case apply a ligature above the clot. Inflammation is met by rest, elevation, painting the neighboring parts with dilute tincture of iodin, and applying about the ulcer ichthyol ointment. For calloused edges, blister, employ radiating incisions, or cut the edges away. Ordinary thick edges should be strapped. In strapping use zinc oxid adhesive plaster and do not completely encircle the limb (Fig. 81). When the parts are adherent the ulcer is immovable, being firmly anchored to structures beneath it. In such

a condition completely or partly surround the sore with a cut through the deep fascia (Fig. 80). This cut sets the ulcer free from its anchorage and permits it to contract. Edematous granulations require dry dressings and pressure by a flannel bandage, a rubber bandage, or adhesive plaster. If the bottom of the ulcer is *foul*, dry it and touch with a solution of acid nitrate of mercury (x:8) or with crystals of pure carbolic acid. Repeat this every third day and dress with hot antiseptic fomentations until granulations appear. Superfluous granulations (proud flesh) should be cut away with scissors,



Fig. 81.—Strapping an ulcer of leg (Keen's Surgery).

scraped away, or burned down with a strong solution of silver nitrate, with the solid stick of lunar caustic, or, better, with pure carbolic acid, which causes much less pain than does silver. Absence of granulations or scantiness of granulations means deficiency of blood-supply. The surgeon endeavors to bring more blood to the part, and to do this induces inflammation. The usual method of procedure is to apply daily to the sore a solution of nitrate of silver (10 or 15 grains to the ounce). Argyrol of a strength of 25 per cent. is not painful and is as efficient. In obstinate

cases blister the ulcer or scrape it, or paint it with tincture of iodin, or apply pure carbolic acid, or touch it with the actual cautery.

Irritable ulcer is due to exposure of a nerve and destruction of its sheath (page 173). Find with a probe the painful point and incise it with a tenotome, or curet the ulcer or burn it with the solid stick of silver nitrate.

If healing entirely fails, skin-graft. Among the methods of skin-grafting are—(1) Reverdin's, (2) Thiersch's, and (3) Wolfe's. (See Plastic Surgery.)

When a man having an ulcer must go out and about, the camphor treatment can be employed (page 171), Unna's dressing may be applied (page 170), or the patient can use a firmly applied roller, or, better still, a Martin bandage. Martin's bandage, which is made of red rubber, limits the amount of arterial blood going to the ulcer and favors venous flow from the sore and its neighborhood. The bandage should be used as follows: Before getting out of bed spray the sore with hydrogen peroxid by means of an atomizer, remove the froth with absorbent cotton, wash the leg with soap and water, dry it with a towel, dust the skin with borated talcum powder, and apply the bandage. All of these things should be done before putting the foot to the floor. At night, after getting on the bed, remove the bandage, wash it with soap and

water, dry it with a towel, hang it unrolled over the back of a chair to air, and again cleanse the leg and ulcer. If these rules are not strictly observed, the Martin bandage will produce pain, suppuration, and eczema of the leg.

Tuberculous Ulcers (see pages 249, 250).

Syphilitic Ulcers (see page 324).

A healthy ulcer is covered with small, bright-red granulations which do not bleed on touching, are painless, and grow rapidly. The edges of the sore are soft and show the opalescent blue line of proliferating epithelium. The sore is movable, the discharge is purulent and yellow, and the parts about are not inflamed.

Various Ulcers.—The fungous or exuberant ulcer is produced by interference with the return of venous blood from the part, and it is specially common after burns and other injuries when cicatricial contraction causes venous obstruction. The granulations are large, deep red in color, bleed when touched, form rapidly, and mount above the level of the skin. The discharge from a fungous ulcer is profuse, thin and bloody. In the treatment of such an ulcer venous return must be favored by bandaging and by elevation of the part. If the edges are very thick, divide them in a number of places. The superfluous granulations should be burnt down with lunar caustic or pute carbolic acid or should be cut off. Strapping with adhesive plaster or the use of a rubber bandage does good. The sore can be dressed with europhen, aristol, or dry aseptic gauze.

A varicose ulcer is an ulcer complicated by varicose veins. It is usually single, is oval, round, or irregular in outline, and is most often seen above the inner malleolus. Its edges are thick, everted, and swollen. The swelling is largely due to edema, and is found to pit on pressure. The edges are not undermined, but slope gently to the floor of the ulcer. The floor is usually covered with rather large granulations which bleed freely on touching. In a varicose ulcer the destruction of tissue often begins at the margin of a congested area and advances toward the center. Such an ulcer is usually surrounded by eczema. To aid the healing of a varicose ulcer it is first of all necessary to favor the return of venous blood from the part by position and bandaging. Martin's bandage is very useful and the daily use of the hot-air apparatus is of value. It may be necessary to operate on the veins.

Erethistic, irritable, or painful ulcers are very sensitive, a condition due to the exposure of nerve-filaments and destruction of nerve-sheaths. Irritable ulcers are especially found near the ankle, over the tibia, in the anus (fissure), or in the matrix of the nail (ingrowing nail). Fissure of the anus is considered on page 1172. An ingrowing nail is sometimes encountered on the finger but far more commonly affects the toe. The great toe is especially apt to suffer. We call it ingrowing nail but the condition is really overgrowing skin. As a result of wearing ill-fitting boots or stockings, especially shoes which are too short or are pointed, the toes are forced together and the skin the edge of the nail is pushed open. After a time an ulcer forms.

When a nail begins to ingrow the condition can usually be arrested by wearing well-fitting shoes and stockings, allowing the nail to grow somewhat long and cutting it square across instead of cutting away the troublesome tomer. Daily a little absorbent cotton should be packed under the ingrowing comer. In more severe cases under local anesthesia, cut away the overlapping skin and a portion of the flesh on the side of the toe, split the nail lon-

gitudinally, remove the ingrown portion of nail and a corresponding part of the matrix.

An erethistic ulcer of the cutaneous surface is treated as follows: Curet and touch with pure carbolic acid or with the solid stick of silver nitrate. Chloral, gr. xx to the ounce, allays the pain; so do cocain and eucain for a time. In some cases the painful area can be located with a probe and the nerve-filament divided with a tenotome.

The indolent ulcer shows no tendency to heal. In such an ulcer there is usually venous congestion from varicose veins or from cardiac weakness. A great mass of scar-tissue forms at the base and edges, which fastens the ulcer to bone or fascia, so that the edges cannot contract. Healthy granulations cease to form. The edges of such an ulcer are thick, smooth, immovable, and free from tenderness. Granulations are entirely absent or there are seen here and there a few unhealthy granulations. The discharge is thin, sero-purulent, and offensive. The parts about the ulcer are congested and pigmented. The pigmentation is due to the fact that in the area of chronic congestion numbers of red blood-cells have been disintegrated. Such an ulcer is treated by making incisions to loosen the base and edges, so that contraction can take place. Venous congestion is corrected by means of position, the use of compression, and in some cases the administration of cardiac stimulants. In all cases the surgeon employs stimulating applications to the ulcer in order to increase the supply of arterial blood.

The callous ulcer is the most chronic form of indolent ulcer and is sunken deeply below the level of the skin. Its border is hard and knobby. Its floor shows no granulations, and is either smooth and glistening or foul and liver-colored. The discharge is thin and scanty, and the ulcer varies little in appearance from week to week or even from month to month. The treatment consists in scraping and cauterizing the ulcer; making radiating incisions through the margins and floor or elliptical incisions about the ulcer; applying antiseptic dressings and a firm bandage. In some cases the ulcer should be strapped. The daily baking in the hot-air oven is often of great benefit. In severe cases it is necessary to extirpate the ulcer and apply skin-grafts.

Hemorrhagic ulcers bleed easily and profusely. Pressure must be applied; it is sometimes necessary to cut or burn away the granulations.

Phagedenic Ulcers.—The phagedenic ulcer results from the profound microbic infection of tissues debilitated by local or constitutional disease, and is commonly venereal. This ulcer has no granulations and is covered with sloughs; its edges are thin and undermined, and it spreads rapidly in all directions. Such an ulcer should be touched with strong caustics or Paquelin's cautery, and dressed with iodoform gauze and antiseptic fomentations. Tonics and stimulants should always be administered.

The edematous ulcer may result from impediment to the venous return or, as Nancrede points out, may be produced by the persistent use of poultices or wet dressings upon any ulcer.\* It is most often met with in tuberculous processes and is occasionally seen when varicose veins exist. The granulations are large and pale, and are apt to bend over like unsupported vines. The discharge is profuse and seropurulent. The edges are softened and desquamating. An edematous ulcer requires dry dressings, stimulation, and compression.

A rodent or Jacob's ulcer, noli me tangere, or cancroid ulcer, is a superficial epithelioma developing usually from sebaceous glands, sweat-glands, or hair follicles. It requires scraping and cauterization, or, what is better, excision (page 390).



Fig. 81 - Marjolin's ulcer in a man twenty years of age, arising in the cicatrix of a burn.



Fig. 83.—Same case as Fig. 82, after excision and skin-grafting by the Thiersch method.

Marjolin's ulcer (Figs. 82-84) is an epithelioma arising from a chronic ulcer or an old cicatrix. The malignant change begins at some point of the edge of the ulcer, and its first evidence is induration. The induration spreads

slowly and comes to involve a considerable part of or even the entire ulcer. Marjolin's ulcer is the seat of scalding, darting pain; the discharge is profuse, ichorous, and foul, and the floor of the ulcer is uneven, warty, or cauliflower-like. The anatomically related lymph-glands eventually become involved. This involvement is seldom early because induration has blocked lymph-channels. In order to confirm the diagnosis a bit of tissue should be removed, and the removed piece must include a portion of the edge of the ulcer and of some apparently sound tissue beyond it. If a microscopical examination shows epithelial infiltration of the apparently sound tissue, a diagnosis of malignant disease must be made. In an early stage of such an ulcer free extirpation and removal of the anatomically related glands may cure the patient. In a more advanced case, if an extremity is involved, amputate and clear out the related lymphatic area. In a very advanced case use the x-rays.



Fig. 84.—Marjolin's ulcer, arising from a chronic ulcer of the leg.

Fig. 82 shows a Marjolin's ulcer in a man twenty years of age. It arose in the cicatrix of a burn. I removed it and applied Thiersch grafts to the raw surface.

Decubitus, or bed-sore, is due to pressure upon an area of feeble circulation (page 195). It is in most instances a condition of gangrene.

Neuroparalytic or trophic ulcer is due to impairment of the trophic nerve-fibers or of the trophic centers in the cord.

The perforating ulcer, as it was named by Vesigne, is believed to result from peripheral neuritis. It is certain, however, that in some of these cases there is arterio-sclerosis and it has been held that the vascular sclerosis is the real cause and that the nerve changes are secondary to the vascular changes. My own belief is that perforating ulcer is a condition dependent upon both arteriosclerosis and peripheral neuritis, traumatism usually being the exciting cause of the ulcer. It is met with most frequently in diabetics, but may be encountered in the victims of chronic alcoholism, injuries and diseases of the spinal cord, injuries and diseases of nerves, Bright's disease, and syphilis. I have

seen this ulcer in an individual with a fractured spine, in two tabetics, and in several diabetics. The perforating ulcer commonly affects the plantar surface of the metatarsophalangeal joint or the pulp of the great toe or little toe about a callosity or corn. It may arise on the heel or the sole or the side of the foot. It is usually unilateral but sometimes both feet are affected. Very rarely it affects the palm of the hand. The parts about the corn inflame, and pus forms and reaches into the bone. A sinus evacuates the pus by the side of the corn or callosity or the center of the callosity exhibits a blister containing sero-pus. A portion of the callous mass is cast off and a shallow ulcer is often exposed. This where is small, has a punched-out appearance, and is surrounded by calloused margins. The ulcer penetrates deeply and after a time the bone is laid bare or the joint opened. The margins of the ulcer or sinus exhibit sprouting granulations and these are encircled by an area of markedly thickened epidermis. In very rare cases more than one ulcer is present on the foot. The discharge from a perforating ulcer is thin and scanty and the ulcer, which slowly advances, is very chronic. It is not painful and is slightly, if at all, tender. The foot is cold and often edematous and the parts about the ulcer may be anesthetic. The ulcer may heal when the patient is kept in bed and open again when he gets about. The disease is far more common among males than among females and is most often met with in the fourth or fifth decades of life. As this ulcer may be present in anesthetic leprosy, in diabetes, peripheral neuritis, syphilis, in a paralyzed limb, and tabes dorsalis, and as the part on which it occurs is apt to be sweaty, cold, and more or less anesthetic, and as the sore may be hereditary, it is usually set down as trophic in origin. In treatment of a perforating ulcer I follow the plan suggested by Treves. This consists in putting the patient to bed and applying poultices to the sore. Every time a poultice is removed the raised epithelium around the ulcer is cut away and then the poultice is reapplied. In about two weeks an ulcer remains surrounded by healthy tissue. Treves treats this sore with glycerin made to a creamy consistency with salicylic acid, to each ounce of which mixture mx of carbolic acid have been added. He directs the patient to wear during the rest of his life some form of bunion-plaster to keep off pressure. If in a perforating ulcer the bone is diseased, it must be removed. If the patient is diabetic he must be placed on antidiabetic diet and drugs. Nerve-stretching has been recommended as the proper treatment for perforating ulcer, but I have never tried it. No matter what treatment is employed, the sore is apt to reappear in the old situation or an adjacent region, when the part is subjected to pressure. In order to prevent pressure upon the region of ulceration some advise the use of an artificial leg, the knee being kept bent. It may be necessary to amputate the toe or the foot.

The scorbutic ulcer is covered with a dark-brown crust, beneath which are pale and bleeding granulations. The parts adjacent are of a violet color.

Epitheliomatous, sarcomatous, tuberculous, and syphilitic ulcers and ulcers of the stomach and duodenum are considered under these respective diseases.

Curling's Ulcer.—This is an ulcer of the first portion of the duodenum which in rare cases follows an extensive burn of the cutaneous surface. It is small, clean cut, and deep and is due to embolism, the emboli being hyaline material precipitated from the blood. The treatment is gastro-enterostomy,

If perforation occurs the treatment is as for any other perforating duodenal ulcer.

Fistula.—A fistula is an abnormal communication between the surface and an internal part of the body, or between two natural cavities or canals. The first form is seen in a rectal fistula, a urethral fistula, or a biliary fistula; and the second form is seen in a vesicovaginal fistula. Fistulæ may result from congenital defect, as when there is failure in the closure of the branchial clefts, and can arise from sloughing, traumatism, and suppuration. Fistulæ are named from their situation and communications. For instance, a pleural fistula, an intestinal or fecal fistula, a rectal fistula, an anal fistula, a gastric fistula, a bronchial fistula, a vesical fistula, a biliary fistula, etc. Many fistulæ are tuberculous and lead to some deeply placed tuberculous focus. A fistula in communication with a viscus (for instance, the gall-bladder) may be maintained by an obstruction of the duct of that viscus the removal of which cures the fistula.

A sinus is a tortuous track opening usually upon a free surface and leading down into the cavity of an imperfectly healed abscess. A sinus may be an unhealed portion of a wound. Many sinuses are due to pus burrowing subcutaneously. A sinus fails to heal because of the presence of some irritant fluid, as saliva, urine, or bile; because of the existence of a foreign body, as dead bone, a bit of wood, a bullet, a septic ligature, etc.; or because of rigidity of the sinus-walls, which rigidity will not permit collapse. Sinuses may be maintained by want of rest (muscular movements) and general ill health. The walls of a tuberculous sinus are lined with a material identical with the Volkmann's membrane of a cold abscess.

Treatment.—In treating a fistula or a sinus, remove any causative obstruction and any foreign body, lay the channel open, curet, brush with pure carbolic acid, and pack with iodoform gauze. Sometimes cure of a tuberculous sinus may be secured by repeated injections of iodoform emulsion or by injecting a paste of subnitrate of bismuth and vaselin (page 892). The mixture remains in the sinus and serves as a framework for granulations. In obstinate cases of fistula or sinus entirely extirpate the fibrous walls, sew the deeper parts of the wound with buried catgut sutures, and approximate the skin surfaces with interrupted sutures of silkworm-gut. To stimulate a sinus to granulation it is sometimes necessary to touch it throughout with the actual cautery, nitric acid, pure carbolic acid, nitrate of silver fused on a metallic probe, or in a solution of a strength of gr. xl to the ounce, or argyrol of a strength of 50 per cent. Fresh air is a necessity to the patient, and nutritious food and tonics must be ordered. There is some testimony, although scarcely as yet evidence, that the use of bacterial vaccines may at times be of value in the treatment of certain sinuses (see page 46).

## VIII. MORTIFICATION, GANGRENE, OR SPHACELUS.

MORTIFICATION, or gangrene, is death in mass of a portion of the living body -the dead portions being large enough to be visible—in contrast to ulceration. or molecular death, in which the dead particles have been liquefied, cannot be seen, and are cast away. When all the tissues of a part are dead, the protess is spoken of as sphacelus. Gangrene is in reality a form of necrosis, but clinically the term necrosis is restricted to molar death of bone or to death of parts below the surface en masse. In gangrene a portion of tissue dies because of anemia, and the dead portions may either desiccate or putrefy. Gangrene may be due to tissue injury, either chemical or mechanical, to heat or cold, to failure of the general health, to circulatory obstruction, to nerve disorder, the nerves involved being the vasomotor or possibly the trophic, or to microbic infection. A microbic poison can directly destroy tissues. It can indirectly destroy them by causing such inflammation that the products obstruct the circulation, but gangrene can occur when no bacteria are present. The essential cause of gangrene is that the tissues are cut off from a due supply of nourishment, and cell-nutrition is no longer possible. In other words, the essential cause of gangrene is the cutting off of arterial blood. Nancrede says: "Indeed, except when the traumatism physically disintegrates tissues, a stone is reduced to powder, heat or strong acids physically destroy structure, or cold suspends cellular nutrition so long that when this nutrition becomes a physical possibility vital metabolism cannot be resumed, gangrene always results from total deprivation of pabulum." \*

Classification.—Gangrene is divided into the following three great

(1) Dry gangrene, which is due to circulatory interference, the arterial supply being decreased or cut off. The tissues dry and mummify.

(2) Moist gangrene, which is due to interference not only with arterial ingress, but also with venous return or capillary circulation, the dead parts

remaining moist.

(3) Microbic gangrene, arising from virulent bacteria. In this form the bacterial process causes the gangrene, and is not merely associated with it.

The above classification, if unqualified, suggests erroneous ideas. It indicates that there is an essential difference between dry gangrene and moist gangrene, which is not the case. If, when gangrene begins, the tissues are free from fluid, the patient develops dry gangrene; if they are full of fluid, he develops moist gangrene. If the arterial supply is gradually cut off, the tissues are sure to be free from fluid, and the gangrene will certainly be of the dry form. If arterial blood is suddenly cut off, the gangrene may be dry or moist, according as to whether the tissues are or are not drained of fluid. When gangrene results from inflammation, strangulation, and infection, it is certain to be of the moist variety, because the tissues are sure to be filled with fluid.

Nancrede says, in his very valuable work on the "Principles of Surgery":

"Yet, let accidental inflammation have preceded the final blocking of an
artery, or let ligation of the main artery cause gangrene because the collateral

circulation cannot become developed, and if an aneurysmal sac is so situated as to interfere with a free return of venous blood and lymph, this anemic

gangrene will in both instances prove moist and not dry."

There are many gangrenous processes which belong under one or other of the above heads, namely: congenital gangrene, a rare form existing at birth; constitutional gangrene, arising from a constitutional cause, as diabetes; cutaneous gangrene, which is limited to skin and subcutaneous tissue, as in phlogmonous erysipelas; gaseous or emphysematous gangrene, in which the subcutaneous tissues are filled with putrefactive gases and crackle on pressure; hospital gangrene, which is defined by Foster as specific serpiginous necrosis, the tissues being pulpefied: some consider it a traumatic diphtheria; cold gangrene, a form in which the parts are entirely dead (sphacelus); hot gangrene, which is associated with inflammation, as shown by heat; dermatitis gangranosa infantum, or the multiple cachectic gangrene of Simon: idiopathic gangrene, which has no ascertainable cause; mixed, which is partly dry and partly moist; primary, in which the death of the part is direct, as from a burn; secondary, which follows an acute inflammation; multiple, as gangrenous herpes zoster; diabetic or glycemic gangrene, which arises during the existence of diabetes; gangrenous ecthyma, a gangrenous condition of ecthyma ulcers; pressure, which is due to long compression; purpuric or scorbutic, which is due to scurvy; Raynaud's or idiopathic symmetrical, which is due to vascular spasm from nerve disorder; senile, the dry gangrene of the aged; venous or static, which is due to obstruction of circulation, as in a strangulated hernia; trophic, which is due to nutritive failure by reason of disorder of the trophic nerves or centers; thrombotic, which is due to thrombus; embolic, which is due to embolus; and decubitus, decubital gangrene, or bed-sores due to pressure.

Dry gangrene arises from deficiency of arterial blood. For this reason

Nancrede calls it anemic gangrene.

This form of gangrene is far more apt to result from the gradual than from the sudden cutting off of the supply of arterial blood, and is more common if the blood-vessels are atheromatous than if they are healthy; but even in a person with healthy arteries gangrene will ensue upon blocking of the main artery, if the collaterals fail to supply the part with blood. This form of gangrene can occur after laceration, ligation, or the lodgment of an embolus in the main artery of a limb; but in such accidents considerable fluid usually remains in the tissues and the gangrene is apt to be moist rather than dry.

Non-senile Dry Gangrene.—An embolus may cause dry gangrene in rare instances. If it does so, it is probable that the blocking was not at once complete. When an embolus lodges in an artery and causes dry gangrene, the case runs the following course: sudden severe pain at the seat of impaction, and also tenderness; pulsation above, but not below, this point, after obstruction has become complete; the limb below the obstruction is blanched, cold, and anesthetic; within forty-eight hours, as a rule, the area of gangrene is widespread and clearly evident; the limb becomes reddish, greenish, blue, and then black; the skin becomes shriveled and its outer layer stony or like horn because of evaporation. The entire part may become dry; but usually there are spots where some fluid remains, and these spots are soft and moist, and the dead tissue, where it joins the living, is sure to be moist. The moist areas become foul and putrid, but the dry spots do not. In dry gangrene, at

the point of contact of the dead and living tissues, inflammation arises in the latter structures, a bright-red line forms, and exudation and ulceration take place. This line of ulceration in the sound tissues is called the "line of demarcation." It is Nature's effort at amputation, and in time may get rid of a large portion of a limb, and then heal as any other ulcer. A line of demarcation rarely causes hemorrhage, because it ulcerates through a vessel only after inflammation has caused occlusion by thrombosis. In dry gangrene from arterial obstruction there is gastro-intestinal derangement and also some fever. The gangrene does not extend up to the point of obstruction, but only to a region in which the anastomotic circulation is sufficiently active to permit of the formation of a line of demarcation. Below this point inflammatory stasis arises, but before this can go on to ulceration the parts die. In cases where the arterial obstruction is sudden and complete the limb swells decidedly. This is due to the sudden loss of vis a tergo in the arterial system, venous reflux occurring and fluids transuding. In such a case the tissues contain fluid and putrefy, and the process, though due to the cutting off of the arterial circulation, is moist gangrene. Dry gangrene attacks the leg more often than the arm. A thrombus in an artery rarely causes gangrene except in the aged, as the collateral circulation has time to adjust itself; but gangrene may follow thrombus formation, and when it does it comes on more slowly than does gangrene from embolus, and is certain to be of the dry form.

Treatment of Non-senile Dry Gangrene.—When injury or blocking of a healthy artery causes us to fear the onset of dry gangrene, the patient should be placed in bed and the part elevated a little, kept wrapped in cotton-wool and surrounded with bottles filled with warm water. If gangrene begins, wait for a line of demarcation, and while waiting dress the dying and dead parts antiseptically, wrap the extremity in cotton and keep it warm, and see to it that the patient gets plenty of sleep and nourishment. It is also advisable to give tonics and stimulants. When a line of demarcation forms, amputate well

Senile gangrene, chronic gangrene, Pott's gangrene (Fig. 85), is a form of gangrene due to feeble action of the heart plus obliterating endarteritis

or atheroma of peripheral vessels. The vessels do not carry a normal amount of blood, and may at any time be occluded by thrombosis. In a drunkard, or in a victim of syphilis or tubercle, the changes supposed to characterize old age may appear while a man is young in years. It was long ago said,



Fig. 85.-Senlle gangrene of the feet (Gross),

with truth, "a man is as old as his arteries." Senile gangrene most often occurs in a toe or the foot.

Symptoms.—A man whose vessels are in the state above indicated is generally in feeble health and has a fatty heart and an arcus senilis (a red or white

line of fatty degeneration around the cornea). His toes and feet are cold and feel numb, and they "go to sleep" very easily, and he suffers from cramp of the legs and feet. He is dyspeptic and short of breath, and his urine is frequently albuminous. The arteries are felt as rigid tubes, like pipe-stems. He is in danger of edema of the lungs and of dry gangrene of the toes. A slight injury of a toe—for instance, cutting a corn too close—will produce extensive inflammatory stasis followed by thrombosis, which completely cuts off the blood-supply and causes gangrene of the part. Gangrene is usually announced by the appearance of a purple and anesthetic spot followed by a vesicle which ruptures and liberates a small amount of bloody serum and exposes a dry floor. In the parts about the gangrenous area there is often burning pain. The circulation in the tissues immediately adjacent to the dead spot is retarded or stagnated, the parts being purple and the color not disappearing or disappearing slowly under pressure. If the color fades under pressure it



Fig. 86.—Dr. Keller's case of spontaneous amputation of a foot and part of a leg in a condition of senile gangrene.

returns slowly when pressure is removed. The parts a little further removed are hyperemic, the color disappearing rapidly on pressure, and returning rapidly when pressure is removed. The dead parts do not putrefy at all or do so but slightly, hence the odor is never very offensive and is usually trivial. They are anesthetic, hard, leathery, and wrinkled, and resemble a varnished anatomical specimen or the extremity of a mummy (hence the term mummification). Before the line of demarcation forms there is burning pain; after it forms pain is rarely present. If embolism or thrombus in a dis-

eased vessel caused the gangrene, the pain is severe at the point of impaction. In senile gangrene the distal portion of the dead area is always dry, the part nearer the body being generally somewhat moist. The process may be very limited or it may spread up to the knee. As it spreads the area of hyperemia advances at the margin, the area of stasis follows, and the zone of gangrene becomes more extensive. When tissues are reached, the blood-supply of which is sufficiently good to permit of inflammation going beyond the stage of stasis and to allow of stasis without extensive thrombosis, Nature tries to limit the gangrene by the formation of a line of demarcation. A line of demarcation may begin, but prove abortive, the tissue mortifying above it. This proves that tissue near the line is in a state of low vitality. The line of demarcation may prove durable and in some few cases spontaneous amputation takes place (Fig. 86). When a limited area is gangrenous, constitutional symptoms are trivial or

absent; but when a large area is involved, the fever of septic absorption exists. Death may ensue from exhaustion caused by sleeplessness and pain, from septic absorption, or from embolism of internal organs. In many cases of senile gangrene clots are formed in the superficial femoral artery or its branches (Heidenhain), an observation it is important to bear in mind when amputating.

Prevention of Senile Gangrene in the Predisposed.—Such a patient must avoid injuring his toes and feet. Cutting his corns carelessly is highly dangerous, and any wound, however slight, requires rest and antiseptic dressing. The victim of general atheroma must wear woolen stockings, put a rubber bag containing warm water to his feet on cold nights, and attend to his general health. A little whiskey after each meal is indicated, and occasional courses of nitroglycerin are desirable.

Treatment of Senile Gangrene.-When gangrene occurs, if it is limited to one toe or a portion of several toes, if it is a first attack, if there is no fever or enhausting diarrhea, if there is no tendency to pulmonary congestion, if the appetite is fair and sleep refreshing, it is best to avoid radical interference and to await the formation of a line of demarcation. While awaiting the line of demarcation dress the part antiseptically, raise the foot several inches from the bed and surround the part with bottles of moderately warm water. Very warm water may do harm. Give the patient nourishing diet, stimulants, and tonics; see to it that he sleeps, and during the spread of the gangrene watch for fever, diarrhea, pulmonary congestion, and kidney failure. When a line of demarcation forms, dress with warm antiseptic fomentations and iodoform, and every day pick away dead bits with the scissors and forceps. A tendon or ligament should be cut through and a protruding phalanx should be divided with a Gigli saw. If an ulcer forms skin-grafts may be applied. In many cases healing will occur; but even when the parts heal, the patient will always be in deadly peril of another attack. If the gangrene shows a tendency to spread, if it involves more than a portion of several toes, if it is not a first attack, if there is sleeplessness, fever, exhausting diarrhea, anorexia, or a strong tendency to pulmonary congestion, do not delay, but at once amputate high up. If the gangrene shows no tendency to limit itself, or if the patient develops sepsis or exhaustion, at once amputate high up. The best point at which to amputate is above the knee, so that the deep femoral artery, which rarely becomes atheromatous, will nourish the flap and gangrene will not occur. It has been pointed out that the superficial femoral artery and its branches often contain a clot. Never amputate below the tubercle of the tibia. Some operators disarticulate at the knee-joint. Heidenhain affirms that so long as the gangrene is limited to one or two toes we should merely treat it antiseptically, elevate the limb, and wait for the dead part to be cast off spontaneously, if, however, it extends to the dorsum or sole of the foot, we should amputate at once above the knee. He further states that gangrene of the haps almost always occurs in amputations below the knee, and high amputation is indicated in advancing gangrene with or without fever.\* When amputation has been performed and the Esmarch band has been removed and no arterial bleeding takes place from the superficial femoral artery, a clot is

<sup>\*</sup>Deutsche medicinische Wochenschrift, 1891, p. 1087.

rubber catheter or a filiform bougie and break up the clot. When blood flows we are sure that the clot has been washed out.\*

Some surgeons have practised arteriovenous anastomosis between the femoral vein and common femoral artery in hopes of establishing sufficient circulation to prevent impending or to cure existing gangrene. The results are as yet inconclusive, but not very promising.

Moist or Acute Gangrene. - In moist or acute gangrene (Fig. 87) the



Fig. 87.-Acute gangrene (Gross).

dead part remains moist and putrefies. As Nancrede points out, there are two forms of moist gangrene: "that limited to the areas actually killed by a traumatism, with some surrounding tissue which dies," and

"that which tends to spread widely, this latter being usually caused by specific micro-organisms, an intense, widespread, pyogenic inflammation resulting, involving the subcutaneous and intermuscular cellular planes, by strangulation of the vessels by which all blood-supply to the remaining soft parts is destroyed."† In a case of moist gangrene the parts remain moist, either because the main artery has become suddenly blocked, and the tissue fluids are not urged by sufficient vis a tergo to cause them to flow out of the limb, or because the main vein is blocked. It may arise in a limb after ligation, obstruction, or destruction of its main artery, main vein, or both; after long constriction, as by a tight bandage; after crushes and lacerated wounds; and after thrombosis of the vein. Moist gangrene may follow severe pyogenic infection, or may be due to local constriction (strangulated hernia), crushing, chemical irritants, heat, and cold.

Moist gangrene of a limb may be seen typically in certain cases in which the main vein or artery or both vein and artery are constricted, damaged, or destroyed. The leg swells greatly and is pulseless below the obstruction; the skin, at first pale, cold, and anesthetic, becomes livid, mottled, purple or greenish. A greenish color signifies putrefaction. Blebs are formed which contain a reddish or brown fluid. "These blebs, being caused by the accumulation of serum beneath epithelium which has lost its vital connection with the derm, can be slipped around upon the surrounding true skin, the epithelium readily separating for long distances around, as in a cadaver" (Nancrede). The extremity swells enormously, there may be pain at the seat of obstruction, but there is no pain in the gangrenous area, and sapremic symptoms quickly develop. The bullæ break and disclose the brown derm and sometimes the deeper structures, which are swollen and edematous. The fetor is horrible. Slight or moderate fever usually exist. In mild cases a line of demarcation soon forms. In severe cases in which virulent saprophytes are present the process spreads with great rapidity, neighboring glands enlarge, the temperature is much elevated, no line of demarcation forms, there is profound exhaustion,

<sup>\*</sup>Severeanu. See Mancozet's report before the Second Pan-American Medical Congress.

<sup>†</sup> Nancrede's "Principles of Surgery."

and gases of decomposition accumulate in and distend the tissues and cause crackling when the parts are pressed upon. Such severe cases are in reality

examples of foudroyant or emphysematous gangrene.

Moist gangrene from inflammation is due to pressure of the exudate cutting of the blood-supply, or to loss of blood-circulation because of microbic involvement of vessels and clotting of blood. It occurs typically in phlegmonous erysipelas. When an inflammation is about to terminate in gangrene all the signs of inflammation, local and constitutional, increase; swelling becomes very great and may be due partly to fluid and partly to gas. If gas is present pressure will cause crackling. The color becomes livid or purple. The anatomically related glands are enlarged and the symptoms of sapremia or suppurative fever exist. When gangrene is actually present, the signs of inflammation have passed away, bullæ and emphysema are noted, with great swelling and all the other symptoms of molar death. The sudden cessation of pain is very suggestive of gangrene. The constitutional symptoms are those of suppurative fever and sapremia, or possibly of septic infection.

When a wound becomes gangrenous the surface looks like yellow or gray tow, the discharge becomes profuse and very fetid, and the parts about swell

enormously and gradually become gangrenous.

Treatment of Moist Gangrene.—In extensive moist gangrene of a limb, if the condition is of the form described as mild, in which there are not severe symptoms of sepsis and in which the gangrene is not rapidly progressive, wait for a line of demarcation, and amputate clear of and above it. While waiting for the line to form, dress the dead parts antiseptically, wrap the extremity in cotton, apply warmth, and slightly elevate the limb. Give opium, tonics, nourishing food, and stimulants. In the severe form of moist gangrene (really foudroyant gangrene), amputate at once high above the gangrenous process. In inflammatory gangrene, such as is sometimes associated with phlegmonous erysipelas, relieve tension by incisions, cut away the dead parts, brush the raw surface with pure carbolic acid, dust with iodoform, and dress with hot antiseptic fomentations. Stimulate freely, administer nourishment at frequent intervals, and treat the patient in general as we would a case of sapremia, or suppurative fever. A gangrenous wound is treated as pointed out in the section on Sloughing.

Acute microbic gangrene, fulminating gangrene, emphysematous gangrene, gaseous phlegmon, gangrenous emphysema, gangrene foudroyante, or traumatic spreading gangrene, results from a virulent infection of a wound. It was first described in 1853 by Maisonneuve under the name of gaseous phlegmon. The condition may be due to a mixed infection with virulent streptococci and organisms of putrefaction; or to infection with the bacilli of malignant edema, and putrefactive organisms. Some case are due to the bacillus of malignant edema alone; some are due to the bacillus aërogenes capsulatus of Welch and Flexner. These gas bacilli are found in soil in animal and human feces, in street dirt, and the dust of floors. The injury is usually severe—often a crush which destroys the main artery and renders an anastomotic circulation impossible, sometimes a compound fracture or a gunshot wound. In such severe accidents the limb is much swollen and the pulse below the seat of injury is imperceptible, and the surgeon is often at this time uncertain whether to amputate at once or wait. Emphysematous gangrene is

commonest after compound fractures, and begins within forty-eight hours of the accident. The extremity becomes enormously swollen from edema and gas. The gangrene does not begin at the periphery, as does ordinary moist gangrene, but at the wound edges, which turn red, green, and finally black; the extremity soon undergoes a like change and becomes mortified. The skin peels off, emphysematous crackling, due to gas formed and retained in the tissues, can be detected over large areas, and the extremity becomes anesthetic and pulpy. The gases formed in the tissues are sulphid of hydrogen, sulphid of ammonium, volatile fatty acids, and ammonia. Great fetor is soon noted. The gangrene spreads up and down from the wound, and red lines, due to lymphangitis, run from above the wound. The adjacent lymph-glands swell, and in thirty-six hours the gangrene may involve an entire limb. No line of demarcation forms. The system is soon overwhelmed with ptomains, and the patient suffers from putrid intoxication, with delirium, and often passes into profound collapse with coma and subnormal temperature. Traumatic spreading gangrene must not be confused with erysipelas. In erysipelas the color is red, pressure instantly drives it out, and on the release of pressure it at once returns. In early gangrene the color is purple, pressure fails to drive it out at all or only does so very slowly, and if the surface is blanched by pressure, on the release of pressure the color crawls slowly back. Sometimes emphysematous gangrene, in the form of gangrenous cellulitis, follows a trivial injury such as a puncture, the entrance of a splinter, an abrasion, or a slight cut. The region about the injury becomes red, then livid, and finally green or black. Enormous swelling takes place, partly due to edema, partly to gas, and the swelling and discoloration spread rapidly. Red lines subsequently becoming greenish run toward enlarged lymphatic glands above the gangrenous part. The tissues are rapidly separated and destroyed and the bone is often quickly exposed and infected. The symptoms point to overwhelming sepsis. There is high fever and delirium, and coma and death are apt to ensue. The patient may die in from twenty-four to forty-eight hours. Welch estimates the mortality from gaseous phlegmon at almost 60 per

Treatment.—In acute spreading gangrene of an extremity following a severe injury no delay is admissible. To wait for a line of demarcation is to expect the impossible, and a delay dooms the patient inevitably to death. Amputation must be performed at once high up, the flaps should be brushed with pure carbolic acid, and then every effort is to be made to sustain the patient's strength by the administration of food and stimulants. Antistreptococcic serum may possibly be useful. In cases of acute spreading gangrene following trivial injuries it may be possible to arrest the process by free incisions, thorough drainage, hot antiseptic fomentations, the continuous hot bath, or continuous antiseptic irrigations, stimulants, etc., but in some cases amputation is necessary. Some surgeons, notably Doerfler ("Münchener medicinische Wochenschrift," April 23 and 30, 1901), oppose amputation in cases of spreading gangrene following trivial or moderately severe injury. Doerfler maintains that cases which recover after amputation would have recovered if amputation had not been performed. From this positive statement I am obliged to dissent.

Hospital gangrene or sloughing phagedena is a disease that has prac-

tically disappeared from civilized communities. It formerly occurred in crowded, ill-ventilated hospitals. Some consider it traumatic diphtheria. Koch thinks it is due to streptococci. Jonathan Hutchinson says: "Hospital gangrene is set up by admitting to the wards a case of syphilitic phagedena." It may show itself as a diphtheritic condition of a wound, as a process in which sloughs which look like masses of tow form, or as a phagedenic ulceration. The surrounding parts are inflamed and painful, and buboes form in adjacent lymphatic glands. The system passes into a low septic state.

Treatment.—In treating hospital gangrene ether should be given, the large sloughs removed with scissors and forceps, the parts dried with gauze and cauterized with bromin. The surgeon should take a tumblerful of water and into it pour the bromin, which will fall to the bottom of the glass. The drug can be drawn up with a syringe and injected into the depths of the wound. The wound should be plentifully sprinkled with iodoform and dressed with hot antiseptic fomentations. When the sloughs separate, the sore can be treated as an ordinary ulcer. The constitutional treatment is that employed for sepsis.

Special Forms of Gangrene.—Symmetrical or Raynaud's gangrene arises in severe cases of Raynaud's disease. It is a dry gangrene. Raynaud's disease is a vaso-motor neurosis, seen particularly in children and young



Fig. 88.-Raynaud's disease (Philadelphia Hospital) (Horwitz).

women seem more apt than others to suffer from it. The condition is much commoner in winter than in summer, and cold seems to be an exciting cause. The essential cause of Raynaud's disease is uncertain. In some acute cases associated with fever, albuminuria, and splenic enlargement, it seems to be a part of an acute infectious disease. It can occur in a variety of toxic conditions and in a number of infectious diseases (typhoid fever, for instance). It may develop in the course of gout and also of diabetes. In many cases nuritis exists; in some there is obliterative endarteritis of the peripheral vessels. Some cases seem to be purely hysterical. The fact that attacks of Raynaud's disease are sometimes accompanied by hemoglobinuria has sug-

gested malaria as a possible cause. Raynaud's disease is characterized by attacks of cold, dead bloodlessness in the fingers or toes as a result of exposure to cold or of emotional excitement (local syncope). In the more severe cases there are capillary congestion and mottled, livid swelling (local asphyxia). The patient complains of pain, tingling, numbness, coldness, and stiffness in the affected parts. In some few cases the skin of the face or trunk is attacked. Local syncope is thought to be due to vascular spasm, and local asphyxia to some contraction of the arterioles, with dilatation of the capillaries and venules. It is after local asphyxia that gangrene may appear. A chilblain is an area of local asphyxia. Attacks of Raynaud's disease occur again and again, and may never eventuate in gangrene.

Raynaud's disease is seldom fatal and is often recovered from.

Raynaud's gangrene is most commonly met with upon the ends of the fingers or the toes, but it may attack the lobes of the ears, the tip of the nose, or the skin of the arms or the legs. Sometimes the disease is seen upon the trunk. When gangrene is about to occur the local asphyxia at that point deepens, anesthesia becomes complete, and the part blackens and feels cold to the touch. The epidermis may raise into blebs at the margin of the gangrene, which blebs rupture and expose dry surfaces. A line of demarcation forms, and the necrosed area is removed as a slough. Widespread gangrene from Raynaud's disease is rare; there is not often an extensive area involved—rather a small superficial spot. Recovery is the rule.

Treatment of Raynaud's Disease and of Raynaud's Gangrene.—If an individual suffers from attacks of Raynaud's disease, every effort should be made to improve the general health and to avoid chilling the surface of the body. During the attack employ gentle massage, place the extremity in warm water, and, if pain is severe, give morphia hypodermatically. Amyl nitrite is without value in this condition. When attacks of Raynaud's disease are so severe as to threaten gangrene, put the patient to bed, if the feet are attacked, elevate the legs slightly, wrap the affected extremities in cotton-wool, and apply warmth. If the hands are affected, wrap them in cotton-wool, elevate them slightly, and apply warmth. Massage is useful. When gangrene occurs, dress the part antiseptically until a line of demarcation forms, and then remove the dead parts by scissors, forceps, and antiseptic fomentations. If amputation becomes necessary, which will rarely be the case, wait for a line of demarcation.

Diabetic gangrene often resembles in many points senile gangrene, but the dead portions remain somewhat moist and putrefy. Some attribute it directly to the presence of sugar in the blood. Some think diabetes causes gangrene indirectly by rendering the tissues less resistant to infection and less capable than normally of repair. Many hold that it is of neurotic origin, being the result of nerve degeneration. Heidenhain believes that it is due to arterial sclerosis. That most of the victims of diabetic gangrene suffer from arteriosclerosis is certain. It seems probable that the gangrene is due to infection of tissue predisposed to infection by the presence of sugar and weakened by changes in the nerves and blood-vessels. Diabetic gangrene is most usually met with upon the feet and legs of elderly people, but it may arise at any age and may attack the genital organs, thigh, lung, buttock, eye, back, finger, or neck. It may affect only a single area, may attack several areas, or may be

symmetric. It may arise in any stage of diabetes, from the earliest to the latest. It may begin as a perforating ulcer. It is much more common in men than in women. There are clearly two forms of this condition. In one there is a slowly progressive fairly dry gangrene, probably due to arterial sclerosis. As in senile gangrene, a trivial injury is apt to be the exciting cause. In such a case the urine contains sugar and perhaps albumin, but seldom either acetone or diacetic acid. In the other form an injury, perhaps a trivial one, is followed by a rapidly spreading cellulitis, which seldom forms pus and which eventuates in moist gangrene. In such a case the urine is apt to contain acetone and diacetic acid and there is grave danger of coma. When the gangrene follows a traumatism there are no prodromic symptoms. When it arises spontancously in the skin, it is often preceded by pain of a neuralgic nature and attacks of "livid or violaceous discoloration of the skin, with lowered surface temperature and sometimes loss of sensation" (Elliot). Diabetic gangrene is often superficial, but may become deep if it follows an injury or ulceration. A sufferer from diabetic gangrene is liable to cardiac failure, collapse, and

Diabetic coma is an acid intoxication due to the presence in the blood of acids which do not belong there, the chief of which is  $\beta$ -oxybutyric acid. It commonly comes on rapidly, with vomiting, abdominal pain, weakness, and drowsiness, which soon passes into coma. Sometimes it is ushered in by collapse, at other times by confusion of thought and speech. In coma the respiration is usually slow and deep, but may be sighing. The pulse is small and usually rather frequent. The temperature becomes subnormal, although during the onset it may be elevated. Cyanosis arises, the breath smells of acetone, the patient lies quietly in bed, and the pupils are dilated. In from twenty-four to forty-eight hours, as a rule, the patient dies.

Never fail to carefully examine the urine in every surgical case and especially in every case of gangrene, because diabetes may exist when least

Treatment.—Most surgeons had grown very shy of amputating for diabetic rangene until Küster, of Berlin, warmly advocated amputating above the knee without waiting for a line of demarcation. He showed that if amputation is performed below, the flaps will become gangrenous, and that after high amputation sugar may disappear from the urine. Of 11 amputations by Küster, 6 recovered and 5 died; and of these 5, 3 had albumin in the urine as

well as sugar.

Heidenhain warmly advocated early high amputation, with the making of short flaps, and in the United States, Powers, of Denver, defended the views of Küster ("Amer. Jour. of Med. Sciences," Nov. 11, 1892). Most writers now advocate high operation without waiting for line of demarcation if the gangrene is moist and due to bacteria attacking tissue weakened by diabetes. The same practitioners, if dry gangrene due to arterial changes exists advocate waiting the formation of a line of demarcation before amputating. I agree with Klemperer ("Therapie der Gegenwart," Jan., 1907) that we should reach a conclusion as to the proper course to pursue more from the character of the diabetes than from the nature of the gangrene. If neither diacetic acid nor actione is in the urine, the glycosuria can be much improved and the general health vastly benefited by restricting the carbohydrates and administering

codein or opium. In such a case during the improvement of the glycosuria we await the formation of a line of demarcation, and while waiting, the gangrenous area and the parts immediately above are dressed with warm antiseptic fomentations. When a line of demarcation forms, spontaneous healing will probably occur. If it does not occur, amputate high up.

If the urine, though free from acetone and diacetic acid, contains not only sugar but also quantities of albumin, we cannot dare to wait for a line of demarcation because of the certainty that during the wait the patient will perish of septicemia (Klemperer, ibid.). In such a case perform an immediate

high operation.

If the urine contains acetone and diacetic acid a line of demarcation will

not form, and high amputation must be performed at once.

To put such a patient on a pure meat diet increases the risk of diabetic coma. In order to lessen the risk of coma give bicarbonate of sodium before and after operation. Twenty grains of this drug dissolved in Vichy water are given every two or three hours. If coma arises give intravenously 40 grains of carbonate of sodium in a quart of water.

The worst cases are those in which the urine contains sugar, albumin, acetone, and diacetic acid. In any case if over one grain of ammonia is excreted in twenty-four hours, postpone operation until ammonia is reduced by diet.

In operating, ether and chloroform (especially chloroform) are to be avoided, because either is liable to induce acid intoxication. The operation should be performed under spinal anesthesia.

My experience in diabetic gangrene comprises 4 cases. In each case the urine contained sugar, acetone, and diacetic acid, and in 2 cases albumin was also present. In each case a high ampuatation was performed—1 case (the one with albumin) died of shock; 2 cases died in coma; 1 case recovered.

Operations on Diabetics.—Surgical operations upon diabetics are regarded as very dangerous and are employed by most surgeons only in emergencies. In operations upon such subjects gangrene may rise in the wound or diabetic coma may develop. It is important to remember that glycosuria may result from a surgical condition (head injury, sepsis, etc.), and this temporary diabetes will be relieved by operation. I have seen it in appendicitis, and in such cases operation is not contraindicated, but is imperative. Llewellyn Phillips in a recent article ("Lancet," May 10 and 17, 1902) refers to the temporary glycosuria produced by injury and sepsis. He thinks that diabetes may directly cause cataract and balanoposthitis, but produces gangrene indirectly by causing nerve degeneration and arteriosclerosis. Phillips points out that a surgical condition and glycosuria may exist independent of and uninfluenced by each other, and many such cases can be operated upon, although operation should be avoided if there is serious disease of some important organ (the liver, for instance). Phillips, in the valuable article referred to, insists that the percentage of sugar is not a measure of the degree of danger; that albuminuria adds greatly to the danger; that the presence of acetone in the urine, and also the presence of ammonia, gives a bad prognosis. Phillips's conclusions as to when to operate and when to refuse operation are as follows ("Lancet," May 10 and 17, 1902): An operation for malignant disease in a diabetic can be performed if the operation would be proper on a non-diabetic individual.

Large abdominal tumors can be removed. Cosmetic operations are justifiable if the general health is good and there is not marked arterial disease or nerve degeneration. Operation is justifiable in all emergencies without regard to the condition of the urine. In a diabetic with a surgical malady it is often possible to lessen danger by preliminary treatment. Only an operation of the gratest urgency should be performed if over 1 gram of ammonia is excreted during twenty-four hours; and if aceto-acetic acid or much albumin is present, every case but the most urgent should be postponed and subjected to medical treatment.

I would add to the conclusions of Phillips that the anesthetic is a danger to the kidneys irritated by the secretion of sugar, and it is desirable, when possible, to use local anesthesia, or, as Robt. T. Morris advises, nitrous oxid and oxygen ("Medical News," June 29, 1901), or spinal anesthesia. In two cases I used spinal anesthesia, but in one of them the patient died in coma. Il sugar diminishes in the urine but increases in the blood, the condition is one of danger.

Gangrene from Ergotism.-Ergotism is a diseased condition resulting from eating bread made with rye which has been attacked by a fungus (Claviceps purpurea). In former days it was not unusual to have epidemics of ergotism from time to time, but at present the disease is found in individuals or, at most, in a few of a community. Ergotism is very rare in the United States, but it is not uncommon in southern Russia. It has occurred during the administration of ergot as a drug. Billroth reported such a case. It is never seen in unweaned children. The eating of bread made of diseased rye provokes gastro-enteritis, the evidences of which are abdominal pain of a crampy character, vomiting, diarrhea, and exhaustion. The patient complains of formication and itching of the skin of the extremities; severe, cramp-like, and tingling pains in the limbs, and disorders of vision. The pulse becomes small and slow. In some cases very painful spasms attack the muscles of the extremities and, finally, tonic spasm is noted, and the patient probably perishes from exhaustion after developing general convulsions and passing into coma. In other cases certain areas exhibit "gradual blood-stasis" (Osler), anesthesia, and, finally, gangrene. The gangrene is dry and peripheral. It usually affects the fingers or toes, but may involve an entire limb, and may be symmetric. ergotism is usually recovered from, but acute cases die in from seven to ten The ingestion of ergot in quantity sufficient to produce chronic poisoning causes tonic contraction of the peripheral blood-vessels, degeneration of the inner coat, and thrombosis of some arterioles. It is also maintained that degeneration of the posterior columns of the spinal cord takes place.

Treatment.—Ergotism is treated by forbidding the eating of the poisonous bread, allaying gastro-enteric inflammation, favoring elimination, and administering nourishment and stimulants. If gangrene is threatened, endeavor to prevent it by gentle massage and the application of warmth. If superficial gangrene occurs, dress with warm antiseptic fomentations and elevate the part, and every day take scissors and forceps and remove the loose Tusts. If deeper and more extensive gangrene arises in an extremity wait

for a line of demarcation and amputate above it.

Gangrene from Frost-bite. - Frost-bite is most common in the fingers,

<sup>\*</sup>Pick, in Heath's "Surgical Dictionary."

toes, nose, and ears, but the genital organs, the cheeks, the chin, the feet and legs, and the hands and arms may be attacked. Cold causes a primary contraction of the vessels and pallor and numbness of the part. After reaction the vessels dilate, the part reddens and swells, and a burning sensation or actual pain is experienced. In a trivial frost-bite the swelling and redness usually disappear after a few days, but in some cases the redness is permanent, and in many cases the redness, in the form of local asphyxia, returns under the influence of slight cold (see Chilblains).

In a more severe frost-bite the affected part becomes purple and covered with vesicles, and gangrene may or may not follow. When a part has been badly frozen the peripheral portion dries. The part is deprived of all blood because of contraction of the vessels and because plasma coagulates at a few degrees above freezing. Cold disorganizes the blood, breaking up white corpuscles with the liberation of fibrin ferment. Coagulation of plasma and destruction of red corpuscles with the liberation of hemoglobin subsequently takes place. The thrombosis which is established prevents circulation, and the tissue-cells are damaged beyond repair. The part is bloodless and anesthetic, and a line of demarcation forms. Hence we note that severe frost-bite causes dry gangrene. If a part which is not so badly frozen is brought suddenly into a warm atmosphere, hyperemia takes place when the blood runs into the frosted tissues, blebs form, and moist gangrene may result. Areas of superficial gangrene are not uncommon.

Treatment of Frost-bite and of Gangrene from Frost-bite.—A frost-bite in which the skin is livid and not as yet gangrenous should be treated by frictions with snow or rubbing with towels soaked in iced water. As the skin becomes warmer and congestion disappears the part should be wrapped in cotton-wool. A sufferer from frost-bite should not suddenly be brought into a warm room. When gangrene follows frost-bite, if only small areas are involved, allow the dead parts to come away spontaneously, applying in the meanwhile hot antiseptic fomentations. If separation be delayed by cartilage, ligament, or bone, cut through the retaining structure. If amputation becomes necessary, await a line of demarcation, as it is not possible otherwise to be certain how high tissue damage extends, and to amputate through devitalized parts would

mean renewed gangrene.

Noma.—Noma is a rapidly spreading gangrenous process which is most apt to begin upon the mucous membrane of the gums or cheeks. Noma of this region is known as cancrum oris. Occasionally it begins in the ears, the genitals, or the rectum. When it attacks the vulva it is called noma pudendi. It may originate in the mouth and subsequently attack other regions. Noma is a very rare disease, is chiefly met with in children between the ages of three and ten, but it can attack older persons. (O. Zusch, in "Münchener medicinische Wochenschrift," for May 14, 1901, reports a case in a man sixty-six years of age.) It occurs in girls oftener than in boys. The disease is most frequently encountered in children recovering from an acute disease. It is seen after scarlatina, typhoid, pneumonia, dysentery, and especially after measles; in fact, Osler says that over one-half the cases follow measles. Children of tuberculous tendencies seem more liable than others. Young children who live amid filth and squalor in damp and ill-lighted apartments are most prone to suffer, but that such conditions are not essential to the genesis

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of the disease is shown by the report of an epidemic of noma in the Albany Orphan Asylum. In this excellently situated, well-lighted, and well-ventilated building the children are carefully fed and cared for, and yet 16 cases of noma occurred after an epidemic of measles. (See "An Epidemic of Noma," by Geo. Blumer and Andrew MacFarlane, in "Amer. Journal of Med. Sciences," Nov., 1901.) The disease is thought by many to be due to pus organisms. Lingard describes a bacillus which he considers causative. Blumer and MacFarlane conclude that the disease begins as a simple infection and a mixed infection takes place later. The mixed infection is not always due to the same organism, but is usually due to a long organism of a lep-



Fig. 89.—Noma. Seven days after first appearance of measles child showed gangrenous condition of mouth. Now, three days later, involves both cheeks and under surface of upper and lower lips. Left cheek perforated. Two days before death a septic diarrhea developed which was uncontrollable (Crandon, Place, and Brown).

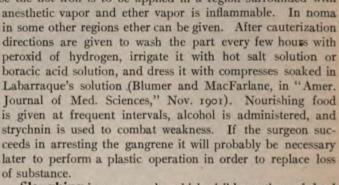
tothrix type ("Amer. Journal of Med. Sciences," Nov., 1901). Some think that cases of noma are due to some spirochæta and it is an interesting observation that in noma the Wassermann serum reaction can be obtained.

In 1908 Crandon, Place, and Brown studied an outbreak of noma. Measles had been through the ward, 46 children had had gangrenous stomatitis, and 6 of them developed gangrene of the lip and cheek. A seventh case of gangrene appeared from another source ("Boston Med. and Surg. Jour.," April 15, 1909). They decide that the lesion is necrosis due to fusiform bacilli, which invades living tissue but rapidly dies in necrotic tissue. Of these 7 cases, 2 recovered. The writers state the duration of the distance as from four to ten days. They do not regard it as proved that noma is contagious and do not advise isolation.

Symptoms.—The disease begins as a sloughing ulcer, and thrombosis and sangrene soon begin. The edges of the ulcer are dark red and indurated. The

gangrene usually spreads with very great rapidity, but in some cases it remains apparently stationary for days at a time. There is little or no pain. The odor is horrible. The disease is frightfully destructive, and if the mouth is involved is apt to destroy the cheeks, lips, eyelids, and large portions of the jaws. There is usually fever, but the temperature may be normal or even subnormal. The pulse is rapid and exhaustion appears early and deepens rapidly. The mortality is large; Bruns says 70 per cent.; Rilliet and Barthez say 95 per cent. ("Amer. Journal of Med. Sciences," Nov., 1901). The cause of death is exhaustion, pyemia, or septic bronchopneumonia.

Treatment.—Administer an anesthetic and destroy the gangrenous area with the Paquelin cautery. In noma of the mouth chloroform is used instead of ether because the hot iron is to be applied in a region surrounded with



Sloughing is a process by which visible portions of dead tissue are separated. These visible portions are called "sloughs"; if they were large, they would be called "gangrenous masses." A large septic slough is a gangrenous mass; a small gangrenous mass is a slough; there is no difference in the process, which corresponds to the formation of a line of demarcation.

Treatment.—Sloughing requires thorough and frequent irrigation with an antiseptic fluid, removal of the sloughs, and antiseptic treatment. An irrigator can be improvised from an ordinary bottle (Fig. 90). Warm antiseptic fomentations are applied until granulation is well advanced. In some cases continuous irrigation with a hot antiseptic fluid is useful; in other cases continued immersion in a hot antiseptic solution is employed.

Phagedena is a process of ulceration (most common in venereal sores) in which the surrounding tissues are rapidly eaten up, the sore becoming jagged and irregular, with a sloughy floor and thin edges. The discharge is thin and reddish, and the encircling tissues are deeply congested. This ulcer has no tendency to heal. Phagedena may attack wounds, but in this age is almost never seen except in venereal sores. When it does so the wound discharge is arrested, the parts about the wound become dark red and swollen, a black slough forms upon the wound and the process spreads rapidly in all directions. The process when it attacks a wound is similar to or identical with a mild case of hospital gangrene, differing from the gangrene in the fact



Fig. 90.— Improvised apparatus for the irrigation of a wound.

that in most cases a line of demarcation forms and the depression is not so great. Phagedena is probably due to mixed infection with pus organisms.

The treatment of phagedena consists in repeated touching with tincture of chlorid of iron and the local use of iodoform, the employment of continued impation or immersion in hot antiseptic fluids, or the application of the cautery, chemical or actual. After using the cautery the part is dressed with hot antiseptic fomentations. Whatever else is done, tonics, stimulants, and

nutritious diet must be given and opium is often required.

Decubitus, Decubital Gangrene, or Bed-sore.—A bed-sore is the result of local failure of nutrition in a person whose tissues are in a state of low vitality from age, disease, or injury. The arterial condition of the aged avors the development of bed-sores. Such sores are due to pressure, aided it may be by some slight injury or by the irritation produced by urine, feces, sweat, crumbs or other foreign bodies in the bed, or by wrinkling of the sheets. The pressure destroys vascular tone, stasis results, thrombosis occurs, and gangrene follows. They occur over the heels, elbows, scapulæ, trochanters, sacrum, and nucha. In some cases after pressure is removed there are stasis, vesication, suppuration, and the formation of an ugly ulcer, surrounded by a zone of swelling and hyperemia. These ordinary pressure-sores arise like splint-sores due to the pressure of a splint upon the tissues over a lony prominence. The pressure interferes with the blood-supply, the weakened tissues inflame, vesication occurs, sloughs form, and an ugly ulcer is exposed. When a bed-sore is about to form, the skin becomes red and edematous. Pressure with the finger drives the color out rather slowly. The color becomes purple or black, a slough forms and separates, and a large, irregular, foul cavity is exposed. The discharge is profuse and offensive. The parts about are swollen and red. If the sore is not upon an anesthetic part, much suffering is produced by it. Bed-sores are most common in paralyzed parts; such parts are anesthetic, and injurious pressure is not painful and does not attract attention, and in such parts there is vaso-motor paresis.

The acute bed-sores of Charcot are seen during certain diseases and after some injuries of the nervous system. These sores are usual over the scrum in acute myelitis, and may appear in four or five days after the beginning of that disease or the infliction of an injury upon the spinal cord. The surgeon sees acute bed-sores upon the buttock of the paralyzed side after brain-injuries, and over the sacrum in spinal injuries. Some believe these sores are due to vasomotor disorder; but others, notably Charcot, attribute

them to disturbance of the trophic nerves or centers.

Treatment of Bed-sores.—The "ounce of prevention" is here invaluable. From time to time, if possible, alter the position of the patient, keep him clean, maintain the blood-distribution to the skin by frequent rubbing with alcohol and a towel, keep the sheet clean and smooth, and in some situations use a ring-shaped air-cushion to keep pressure from the part. When congestion appears (paratrimma, or beginning sore), at once use an air-cushion of a water-bed and redouble the care to frequently change the position of the patient. Not only protect, but also harden, the skin. Wash the part twice daily and apply spirits of camphor or glycerol of tannin; or rub with salt and whiskey (3 ij to 0 j); or apply a mixture of 3 ss of powdered alum, f 3 ij of tincture of camphor, and the whites of four eggs; or paint with corrosive subli-

mate and alcohol (gr. ij to 5j); or apply tannate of lead or equal parts of oil of copaiba and castor oil; or paint upon the part a protective coat of flexible collodion.

When the skin seems on the verge of breaking, paint it with a solution of nitrate of silver (gr. xx to 3j). When the skin breaks, a good plan of treatment is to touch once a day with a solution of silver nitrate (gr. x to 3j) and cover with zinc-ichthyol gelatin. We can wash the sores daily with 1:2000 corrosive sublimate solution, dust with iodoform, and cover with soap plaster, with lint spread with zinc ointment, or with dry aseptic gauze. When sloughs form, cut most of them off with scissors after cleaning the parts, slit up sinuses, and use antiseptic fomentations. In sloughing Dupuytren employed pieces of lint wet with lime-juice and dusted the sore with cinchona and charcoal. In obstinate cases use the continuous hot bath. When the sloughs separate, dress antiseptically or with equal parts of resin cerate and balsam of Peru. If healing is slow, touch occasionally with a solution of silver nitrate (gr. x to 3j). Bed-sores, being expressive of lowered vitality, demand that the patient shall be stimulated, shall be well nourished, and shall obtain sound sleep.

Ludwig's Angina (Angina Ludovici).- This disease, which was first described by Ludwig, of Stuttgart, in 1836, is an acute septic infection about the submaxillary salivary gland and in the cellular tissue beneath the mucous membrane of the filoor of the mouth and of the upper portion of the neck. Ludwig called it "gangrenous induration of the neck" (D. Ludwig, "Med. Correspondez Blatt," p. 21, Feb., 1836, Stuttgart). The disease may arise in an apparently healthy man or during or after an infectious fever. It can arise at any age. The bacteria enter from the mouth by way of abrasions, wounds, ulcerations, or dental caries. It may be caused by delayed development of the third molar, necrosis of the tooth and alveolar process taking place and an abscess forming (G. G. Ross, "Annals of Surgery," June, 1901). In most cases the condition is a pure streptococcic infection or a streptococcic infection associated with infection by some other organism, for instance, staphylococci, pneumococci, or bacilli. In one of Davis's cases it was due to pneumococcus alone; in another, to staphylococcus alone (Gwillym W. Davis, "Annals of Surgery," August, 1906). In a case reported by Lockwood the bacillus of malignant edema was found. The condition is essentially an acute spreading cellulitis about the submaxillary gland. It usually begins about that gland, but in some cases seems to arise about the sublingual gland. It is usually a violent process from the start, but sometimes it is first an indolent swelling in the submaxillary region and becomes violent and begins to spread rapidly after a few days. It spreads along planes of connective tissue to the sublingual region of the mouth and to the pharynx.

The bacteria reach the submaxillary region in the lymph. A lymphgland or perhaps several glands enlarge and are rapidly destroyed, the periglandular cellular tissue becomes involved, and after this spread takes place along connective-tissue planes and not by lymph-glands, and other lymphglands seldom enlarge.

The localization in the submaxillary region, the violence of the inflammation, the rapidity of the spreading, and the subsequent involvement of the pharynx and floor of the mouth are the characteristic features of Ludwig's angina (see T. Turner Thomas, "Annals of Surgery," February and March,

too8). Thomas, in the article just referred to, proves by anatomic studies that the connective tissue in the submaxillary fossa is directly continuous with that in the floor of the mouth. The disease begins as a painful indurated swelling beneath the body of the jaw, the swelling rapidly increases in the neck and may even pass to the level of the sternum. A board-like feel of this swelling is distinctive. The skin may be pale or dusky red. There may or may not be marked tenderness.

After a few hours or a day or two the floor of the mouth becomes involved; as a result of this the tongue is raised and pushed back, the mouth is kept from closing, swallowing becomes difficult, speech is impaired, the saliva dribbles constantly, and dyspnea becomes an alarming feature of the case.

In some cases the temperature is much elevated, but in most it is moderately or only slightly elevated.

If a spontaneous opening should occur it will be within the mouth. Free suppuration may occur or only a little watery pus may form and the pus may be brown and putrid. In many cases the cellular tissue becomes gangrenous. The mortality is high. In Thomas's collection of 106 cases it is seen that 43 died (ibid.), though with the prompt intervention which is now advised the mortality should be much below this figure at the present time. I have had 3 cases and 2 of them died.

Death may take place suddenly. Death is seldom due to septic intoxication or pyemia, but may be. It is usually due to edema of the glottis or to bronchopneumonia.

Treatment.—Operate promptly and incise freely. If there is an infective focus within the mouth, remove it. Make an incision through the swelling in the submaxillary region, carry the incision forward to the median line and divide the mylohyoid muscle. "The finger should be passed upward in the wound until only mucous membrane intervenes between it and the mouth. Gangrenous tissue is cut away, the wound is painted with pure carbolic acid, and dusted with iodoform" (T. Turner Thomas, ibid.). Drainage-tubes are inserted and the part is dressed with antiseptic fomentations. If edema of the glottis exists, tracheotomy should be promptly performed. Stimulants are given with a free hand in Ludwig's angina.

Carbolic Acid Gangrene.—Dressings moistened with a solution of carbolic acid of a strength of from 3 to 5 per cent. if wrapped for a number of hours around a finger or toe, a hand or a foot, may cause dry gangrene. There is but little danger when such dressings are applied to the tissues of the trunk, because these thicker tissues are better nourished and cannot be completely surrounded by the wet dressings. When a dressing wet with a watery solution of carbolic acid is wrapped about the part the water evaporates, and as it does so the carbolic acid becomes more and more concentrated. A well mixed solution seldom causes gangrene. A recent aqueous solution often contains free globules of acid and is particularly apt to cause gangrene (Murphy). It is claimed that a solution of carbolic acid in glycerin never causes gangrene (Pautrier in "Presse Médicale," March 2, 1907). The application of strong acid rarely causes gangrene, but Lévan found 14 reported cases in which it did [J. Lévan, in "Centralbl. f. Chir.," August 14, 1897), and Wallace has reported several more ("Brit. Med. Jour.," May 11, 1907). The continuous application of a solution of a strength of 3 per cent. or over is very dangerous and ought

never to be practised. The author has seen 5 cases. Harrington saw 18 cases of gangrene in five years in the Massachussetts General Hospital, and collected 132 cases from literature ("Boston Med. and Surg. Jour.," May 2, 1901). Carbolic acid gangrene is due to great exudation into the cellular tissue, blocking the circulation (Housell), and the production of arterial thrombi, a condition to which the patient is predisposed by the injury and often by tight bandaging. The dressing is frequently applied by a druggist; it produces anesthesia of the part, and the dressing may perhaps not be removed for days, gangrene perhaps progressing beneath. In the author's 5 cases pain was absent and there was no smokiness of the urine or any other evidence of absorption of the drug. Dressing of lysol and of alcohol may produce gangrene, but the necrosis is more superficial than that due to carbolic acid.

Treatment.—If the gangrene is very superficial, recovery may be obtained by using hot fomentations and picking the dead parts gradually away. In most cases the finger or toe is completely destroyed, a line of demarcation

forms, and amputation is required.

Post-febrile Gangrene. - Dry or moist gangrene may follow any fever, but is most frequent after typhoid (may follow typhus, influenza, measles, scarlet fever, etc.). Keen tells us that the gangrene resulting from arterial obstruction is apt to be dry, and that from venous obstruction is usually moist. The same observer has collected 203 cases.\* It is most usual in the lower extremities, but may appear in the upper extremities, cheeks, ears, nose, genitals, lungs, etc. Some writers have assigned as the cause weakness of cardiac action, but most observers believe an obstructing clot is the usual cause. This clot may come from the heart, but is in most cases secondary to endarteritis due to the action of the toxins of the bacilli of the specific fever. Keen shows that in some cases gangrene is due to obstruction of peripheral vessels and not of a main trunk. In rare cases gangrene arises after thrombophlebitis. Gangrene may begin as early as the fourteenth day of the fever, but usually appears late in the disease and may arise far into convalescence. In the course of a continued fever frequent examinations should be made to see that gangrene is not arising. Particular examination from time to time should be made of the lower extremities, and in young girls, of the genitals. If gangrene arises in an extremity, apply antiseptic dressings, wait for a line of demarcation, and then amputate. If gangrene occurs in other regions, remove the dead tissue and employ hot antiseptic fomentations.

Rules when to Amputate for Gangrene.—In dry gangrene, due to obstruction of a non-diseased artery, wait for a line of demarcation. In senile gangrene, if it affect only one or two toes, let the dead parts be cast off spontaneously. If a greater area is involved or the process spreads, amputate above the knee without waiting for the line. In ordinary moist gangrene, if there are not severe symptoms of sepsis, and if the gangrene is not rapidly progressive, wait for a line of demarcation. In the severer cases amputate at once high up. In traumatic spreading gangrene amputate at once. In diabetic gangrene amputate at once, high up. In ergot gangrene, in carbolic acid gangrene, in post-jebrile gangrene, in Raynaud's gangrene, and in frost gangrene wait for a line of demarcation.

<sup>\*</sup> Keen on the "Surgical Complications and Sequels of Typhoid Fever."

## IX. THROMBOSIS AND EMBOLISM.

Thrombosis is the ante-mortem coagulation of blood in the heart or in a vessel, the coagulum remaining at its point of origin and plugging up the vessel partially or completely. The process, and also the condition significant of the process, is known as thrombosis; the clot is called the thrombus. This process is an essential part in the arrest of hemorrhage; it occurs in phlebitis and arteritis, and affords a frequent basis for embolism. The thrombus is composed of red corpuscles, white corpuscles, fibrin, and platelets in varying proportions. Thrombi may form in the veins, in the arteries, in the capillaries, or in the heart. Clotting is due to destruction of white blood-cells, fibrin ferment being set free, causing the union of calcium and fibrinogen and thus forming fibrin. Thrombosis is more common in the veins than in the arteries, the slow blood-current and the existence of valves favoring the deposit, though not causing it. A thrombus forms gradually, being deposited layer by layer; hence it is stratified or laminated. Fig. or shows a thrombus in a vein. All thrombi are either injectious or simple, the latter

being also called aseptic or bland. Thrombi are also spoken of as fibrinous, red, hemostatic, leukocytic, etc.

Causes of Thrombosis.-In the formation of thrombi four conditions are to be considered, viz., chemical alterations in the blood, a bacterial attack on the intima, tissue changes in the inner coat of the vessel, and slowing of the circulation. One, several, or all of these conditions may exist in a case of thrombosis. In arteries the chief causes are disease of the coats and embolism. In veins the chief causes are injury and infectious phlebitis. Capillary thrombi may be due to propagation from veins or arteries or may form in the capillaries. The latter condition is seldom seen. The essential cause of all intravascular thrombi is damage to the endothelial coat and in most Fig. 91.-Thrombus in the instances the damage is effected by bacteria, hence most



saphenous vein (Green).

cases of thrombosis seen by the surgeon are infectious. Any condition which causes the blood to contain an excess of fibrin-forming elements favors thrombosis, in the sense that a slight injury of the vascular endothelium will be followed by dot formation. Among conditions favoring thrombosis we must note particularly slowing of circulation, however, caused. A special predisposing condition is the retarded circulation in tuberculosis, influenza, and fevers, the blood clotting behind the vein-valves after the endothelium has been damaged by toxins. Among other favoring states are inflammations; wounds; fractures; the pressure of a bandage or of a splint; varicose veins; ligation of a vessel; injury of a vessel; foreign bodies in a vessel; atheroma in arteries; sutures in a vessel; certain diseases, such as gout, typhoid fever, pregnancy, and septic processes; phlebitis or arteritis arising in the vessel or from extension of surrounding inflammation; and the entrance of specific organisms.

It has been asserted that so long as the endothelium of a vessel is uninjured a clot does not form. Slowing of the blood-current in aseptic conditions,

it is now taught, will not cause thrombosis. One of the functions of the endothelial coat is to keep the blood fluid by preventing corpuscular disintegration. A thrombus can form only when fibrin ferment is set free, and fibrin ferment can be set free only when white corpuscles disintegrate. When moving blood coagulates, the third corpuscles or platelets first settle out and form a nucleus and then the leukocytes gather about it. This is known as the white or "antemortem" thrombus—the clot of moving blood. Thrombi from moving blood are rarely pure white; they contain some red corpuscles, forming mixed White thrombi and mixed thrombi are stratified and are at first soft but harden as they age. The red thrombus plugs vessels which are cut across or ligated; it also occurs in septic processes and is formed after death. A primary thrombus remains in the original region of thrombosis. A secondary thrombus forms about an embolism. A propagating or spreading thrombus extends a considerable distance from the seat of initial disturbance. A thrombus soon undergoes a change. An aseptic clot usually "organizes"—that is, the clot is absorbed and is replaced by fibrous tissue. The walls of the injured vessel become filled with leukocytes, leukocytes invade the clot, the vascular endothelium proliferates, and the young cells follow the colonies of leukocytes into the thrombus. The thrombus is gradually removed by leukocytes and replaced by fibroblasts, the new tissue is vascularized and becomes granulation tissue, the granulation tissue is converted into fibrous tissue, and the fibrous tissue contracts. In some instances a thrombus is implanted on the wall of the vessel, and the tube is not permanently occluded. Such a condition may be obtained by the application of a lateral ligature about a small tear in a large vein. In most instances, after the formation of an intravascular



Fig. 92.—Infected thrombus of a vein (schematic).

thrombus, the vessel is converted into a narrow cord of fibrous tissue. A thrombus may degenerate and break down (fatty degeneration), giving rise to emboli or a thrombus may undergo calcification. A calcified thrombus in a vein is known as *phlebolith*. An infected thrombus may undergo liquefaction, infective emboli being set free (Fig. 92).

A clot may propagate in both directions, that is, toward the periphery and toward the center. It was taught for many years that when an artery is ligated a thrombus quickly forms and reaches to the first collateral branch above. This view was formulated in preantiseptic days. It is now known that

when aseptic ligation is performed the thrombus is small and rarely reaches the first collateral branch; and is often actually absent, vascular obliteration being obtained by proliferation of connective-tissue cells and of cells from the endothelial coat. If any infection takes place the clot will reach the first collateral branch. The old rule of surgery was as follows: If an artery is cut near a large branch, tie the branch as well as the artery, in order to permit of the formation of a lengthy clot. This rule is no longer followed unless infection exists or is anticipated.

A clot in a vein often extends a long distance. The author has seen in a post-mortem examination a venous thrombus reaching from the ankle to the vena cava. A common example of thrombus in a vein is the clot formed in the

uterine sinuses in a condition of puerperal sepsis, a clot which tends to extend into the iliac and femoral veins. In infectious thrombosis of the lateral sinus, thrombophlebitis arises and the clot tends to extend up to the torcular and into other sinuses and down into the jugular. *Phlegmasia alba dolens* or milk leg is a condition in which the leg or the leg and thigh are swollen and painful because of venous thrombosis or sometimes lymphatic thrombosis.

Lymphatic Thrombosis.—Occasionally occurs in the thoracic duct, axillary lymphatics, or inguinal lymphatics. It is most common in the uterine lymphatics during puerperal fever. Lymphatic thrombosis may be due to infection, to cancer, to tuberculosis, or to change in the lymph itself.

General Symptoms.—The symptoms are dependent on the seat of the obstruction and the presence or absence of infection. An organ or a part of an organ may exhibit functional aberration. The local signs in a vessel accessible to touch or sight are the presence of a clot; if it be in an artery, anemia and the absence of pulse below the clot; if it be a vein, swelling and edema below it. There is usually pain at the seat of trouble, and anesthesia below it. Moist gangrene may follow venous thrombosis, and dry gangrene, arterial thrombosis. Thrombosis of the mesentenc vein is followed by gangrene of the bowel. Infective thrombophlebitis is a spreading inflammation of a vein. A septic thrombus forms and the condition is an early step in pyemia. We see this condition sometimes in the lateral sinus of the brain as a result of suppuration in the middle ear; in any of the cerebral sinuses after infected compound fracture of the skull; and in the uterine veins in puerperal sepsis. Thrombo-arteritis is a spreading inflammation of an artery in which a septic thrombus forms or in which a septic embolus lodges. It occasionally attacks an aneurysmal sac. In infectious thrombophlebitis and in arterial pyemia the symptoms are, of course, those of pyemia. A great danger of thrombosis is embolism, especially pulmonary embolism.

Injectious Thrombosis of the Lateral Sinus.—(See page 823.)

Thrombosis of the Jugular Vein.—This condition is usually infectious and secondary to infectious thrombosis of the lateral sinus or sometimes of the petrosal sinus. It is occasionally due to cancer, tuberculosis, acute rheumatism, or pyemia taking origin from a distant focus. If it is infectious, the chills, the high and fluctuating temperature, and the great exhaustion proclaim the existence of pyemia. Locally the vein feels hard, the adjacent tissues are edematous, the branches of the jugular are visibly distended, there may be linear discoloration over the course of the jugular, and the head is held stiffly with an inclination to the diseased side.

Thrombosis of the Mesenteric Vessels.—The arteries are affected much more commonly than the veins and the superior mesenteric artery far more often than the inferior. Vascular disease is the cause of arterial thrombosis and arterial thrombosis occurs chiefly in those beyond middle life. Venous thrombosis may be primary and has been observed after splenectomy, the dot having propagated to the mesenteric veins. It may occur as a result of any gastro-intestinal or general infection (pyemia, appendicitis, typhoid fever). Secondary venous thrombosis is due to portal obstruction or accompanies arterial mesenteric thrombosis.

Mesenteric thrombosis usually produces sooner or later gangrene of the

gut, but does not always do so.

The period at which gangrene develops after blocking is uncertain; it may arise in thirty-six hours, it may not arise for two weeks or more. The gut becomes distended, bloody serum exudes into the peritoneal cavity, and in most cases into the lumen of the bowel. The mucous membrane undergoes necrosis and perforation occurs. The area involved varies greatly in different cases. In some cases it is very limited, and is rather apt to be in the large intestine. In other cases it is very extensive, and is apt to be in the small intestine. In a case of the author's in the Jefferson College Hospital practically the entire ileum was gangrenous and numerous perforations existed.

In mesenteric thrombosis pain arises rather suddenly and rapidly becomes severe. It is a persistent pain with paroxysmal exacerbations and is usually generalized, though in many cases it has an area of peculiar intensity. pain is accompanied by rapid pulse, growing exhaustion, distention, subnormal temperature, tenderness, a mass appreciable by palpation in the region of the mesentery, free fluid in the peritoneal cavity, nausea, and vomiting. The condition suggests intestinal obstruction. The vomited matter consists first of the contents of the stomach, then of bile, finally becomes stercoraceous,

and sometimes contains blood.

In nearly one-half of all cases blood in considerable quantity passes from the rectum.

Ballance points out that cardiac disease or arterial degeneration suggests the artery as the seat of thrombosis.

The only chance for recovery without operation is the establishment of the collateral circulation, and as the superior mesenteric vessels are terminal vessels this seldom occurs (in only about 5 per cent. of cases).

Thrombosis after Abdominal Operations.—This complication is occasionally encountered and is most often met with in the left side, even when the operation was in the middle line or the right side. It is a rare complication, occurring, according to Professor Clark, 35 times in a series of 3000 operations.

Many explanations have been given of it. A great many surgeons regard it as infectious, but many cases certainly are not. Clark believes it is due to injury of the deep epigastric vein, forcible and prolonged separation of the wound edges by retractors being a common cause. The free anastomosis between the epigastric veins of the two sides accounts for the appearance of thrombosis on one side after operation on the other. It probably in many slight cases is not recognized and it will not be recognized unless the clot reaches the femoral vein, and it requires one or two weeks to reach this vein if it does so at all. When a clot forms in the femoral vein a milk leg develops. The entire extremity swells below the seat of thrombus, the temperature is usually normal but may be slightly elevated.

Thrombosis in General Infections,-In typhoid fever a thrombus may form in the heart, the veins or the arteries. Thrombosis may occur in pneumonia, in influenza and in other fevers, and in tuberculosis. The vessels of a limb, a lung, the brain or the mesenteric zone may suffer. The condition follows bacterial infection, the veins are most prone to suffer and gangrene may ensue.

Thrombosis in Appendicitis. - In about 2 per cent. of cases, according to

Somenberg, this complication is noted. It may affect the femoral or saphenous vein of either side or of both sides, the portal vein or the vena cava, and may occur during an acute attack but is more often noted in an interval.

It is not very unusual to find a liver abscess follow appendicitis, the infection being carried by the portal vein and the condition being known as

septic pylephlebitis (page 1017).

Treatment.—If an aseptic thrombus forms in a large vessel of a limb, raise the limb a few inches from the bed, keep it perfectly quiet to avoid detachment of fragments (emboli), apply a bandage lightly from the toes up, and place warm bottles around the extremity. Maintain rest for four or five weeks. The great danger is the formation of emboli, hence movements and rough handling are to be avoided. Gangrene is another danger, hence it is wise to favor venous return and the development of the collateral circulation by warmth, elevation, and bandaging. In infectious thrombophlebitis, if the vessel is accessible, tie it above and below the clot, open the vessel, remove, irrigate, and pack the

wound with iodoform gauze. The general treatment for a septic condition should be stimulating and supporting. Massage is unsafe in any condition of thrombosis, and is particularly dangerous in septic thrombosis. In thromboarteritis treat as in the thrombo-phlebitis. If gangrene of an extremity follows thrombosis treat as previously directed (page 180). Gangrene of the intestine in mesenteric thrombosis if not too extensive is treated by resection.

The treatment of infectious thrombosis of the lateral sinus is set forth on page 824.



Fig. 93.—Embolus impacted at bifurcation of a branch of the pulmonary artery (Green).

Embolism signifies vascular plugging by a loreign body (usually a blood-clot) which has been brought from a distance. The foreign body is called an embolus. An embolus usually consists of a sepatated or ruptured portion of a thrombus, atheromatous material from a diseased artery, or a bit of fibrin from a diseased heart valve. In some cases an embolus consists of bacteria, or air, or fat, of a fragment of a tumor, or of parasites. In severe burns the blood undergoes changes and jelly-like matter is often precipitated and may cause embolism. Emboli vary in shape, in size, and in consistency. Emboli are divided into simple, bland or aseptic and injectious, toxic or septic. Emboli may arise either in the venous or in the arterial system, but are particularly prone to arise in the veins; they lodge in an artery, in capillaries, or in the veins of the liver. An embolus taking origin in one of the systemic veins passes through the right heart and lodges in a terminal branch of the pulmonary artery. If at this point it disintegrates, smaller emboli pass to the left heart and enter the arterial circulation to be deposited, as are emboli originating in the heart or arteries, in the arteries of an extremity, the kidneys, spleen, or brain. Emboli of the portal circulation lodge in the liver or perhaps pass through that organ and reach the lungs. An embolus is arrested when it reaches a vessel whose diameter is less than its own. It is usually caught just above a bifurcation. When an embolus lodges, it at once partially or entirely obstructs the circulation, and increases in size by thrombosis. Fig. 93 shows an impacted embolus. A nonseptic embolus when lodged usually "organizes," as does a thrombus, and, as described on page 132, is replaced ultimately by fibrous tissue. A soft embolus may disintegrate and permit the re-establishment of the circulation. An embolus may cause an aneurysm. A septic embolus breaks down, forms a metastatic abscess, and sends other emboli onward in the blood-stream.

An embolus is more serious than a thrombus: it causes sudden plugging, which makes dangerous anemia inevitable, and it will produce gangrene if the collateral circulation fails. Embolism of the mesenteric artery causes necrosis of the intestine. In organs with terminal arteries (spleen, kidney, brain, and lung) there is no collateral circulation and embolism causes injarction. For instance, if an embolus lodges in the lung it produces an area of anemia; the removal of all propulsion upon the venous blood



Fig. 94.—Diagram of a hemorrhagic infarct: a, Artery obliterated by an embolus (e); v, vein filled with a secondary thrombus (th); t, center of infarct, which is becoming disintegrated; z, area of extravasation; 3, area of collateral hyperemia (O. Weber).

causes it to flow back and stagnate, and vascular elements exude, forming a wedgeshaped area of red tissue, the embolus being the apex of the wedge. This is known as hemorrhagic or red injurction, and is often seen in the lung (Fig. 94). The white infarction, seen in the brain and kidney, is not due to retrogression of venous blood, but is due to anemia and resulting coagulation-necrosis. A septic embolus causes septic thrombosis and a septic infarction, and a septic infarction is followed by suppuration and the production of a pyemic abscess. emboli of the systemic venous circulation usually lodge in the lungs explains the occurrence of pulmonary embolism after certain operations upon and during certain diseases of the regions drained by the systemic veins.

Emboli formed in vessels of the systemic circulation lodge most often in the lungs, brain, kidney, or spleen. It is because emboli which pass into the portal vein lodge in the liver that operations upon the rectum may be followed by

hepatic embolism and abscess of the liver. General Symptoms.—The symptoms depend upon the organ involved and the presence or absence of infection. They are sudden in onset, and are due to loss of function, which may be permanent or which may be followed by inflammation, softening, or gangrene. In a septic embolus there are symptoms of infection and abscess forms at the seat of lodgment. the course of pyemia a chill usually means the occurrence of embolism. Embolism of the cerebral arteries may cause aphasia, paralysis, or coma. Embolism of the pulmonary artery may cause almost instant death. Embolism of a large artery of a limb produces symptoms identical with thrombus, except more sudden and decided. Below the obstruction the pulse is absent and the limb is swollen with edema, is cold, and is discolored. There is pain at the seat of obstruction. This condition is frequently followed by gangrene. Embolism of the superior mesenteric artery produces symptoms similar to those caused by acute intestinal obstruction, and results in gangrene of a portion of the intestine.

Pulmonary Embolism.—This condition occasionally follows operations and injuries and sometimes develops during certain diseases. I have seen a case after an operation for appendicitis, a case after an operation for varicocele, and a case in a man with a large lumbar contusion to which massage was injudiciously applied. It is not very common. Albanus ("Beiträge klin. Chir.," al) in 1140 abdominal operations found 23 cases. The emboli may be aseptic The condition is most common as a result of thrombosis of the veins of the lower extremities, appendicitis, and strangulated hernia. Certain postoperative pneumonias are embolic. Very small aseptic emboli may cause no symptoms or slight symptoms. When aseptic hemorrhagic infarction occurs there are symptoms. These symptoms are a chill or chilly sensations, moderate fever which may be transitory, dyspnea, rapid pulse, pain in the chest, sometimes rapidly advancing signs of consolidation, often a pleural friction sound, and bloody expectoration. Sometimes immediate death occurs. The mortality is always large (80 per cent.).

A septic embolism causes metastatic abscess and usually suppurating pleuritis, the condition being known as septic embolic pneumonia. Recovery is rare but occasionally occurs. The symptoms are those of pyemia with the

physical signs of consolidation and of pleuritis.

Embolism of the Mesenteric Arteries.—The superior mesenteric is the vessel usually affected. It may arise in pyemia, septicemia, arterial or cardiac disease. The symptoms are practically identical with thrombosis of

the mesenteric vessels (page 201).

Treatment.-Murphy removed an embolism of the femoral and iliac arteries through an incision of the femoral, and then sutured the incision ("Jour. Am. Med. Assoc.," May 22, 1909). The operation was too late to prevent gangrene, but it emphasizes the truth, that an aseptic embolism of a large artery should be treated by incision of the artery, removal of the clot, and suture of the vessel. The treatment long in vogue was as follows: In a limb, keep the part warm in order to stimulate the collateral circulation, elevate the extremity several inches from the bed, apply a bandage lightly from the periphery, and insist on perfect quiet. Massage is unsafe. If gangrene ensues, await a line of demarcation and amputate. In septic embolic arteritis in an accessible region it would be good surgery to act as in septic thrombophlebitis. After an operation upon veins (as the operation for varicocele, for varix of the leg, or for hemorrhoids), after any cutting operation, and after the infliction of a fracture, avoid as much as possible, and for some time, movements or handling, as fragments of thrombus may be detached.

In mesenteric embolism exploratory laparotomy may disclose a perforation which can be closed or a portion of gangrenous gut which can be resected.

In aseptic pulmonary embolism enforce absolute rest, give strychnin and

morphia hypodermatically, and inhalations of oxygen.

In septic embolic pneumonia, pursue the same plan of treatment, unless a large pulmonary abscess forms or an empyema arise. In either case operate.

Fat-embolism in the human being was first noted in 1856 by MacGibbon, of New Orleans, and was first thoroughly described by von Recklinghausen in 1884, although Magendie, in 1827, and Virchow, in 1856, developed it experimentally in animals. It is a process which leads to an accumulation in the

capillaries of liquid fat after injury to adipose tissue, high tension having forced the fat into the open mouths of veins. Fat may be forced into open veins by muscular action, by efforts at repair, or by concealed bleeding. Some little fat may get into the blood by means of the lymphatics and it can also enter by way of the synovial membrane. It is a very common condition, but seldom produces serious trouble, although it is occasionally fatal and is responsible for some otherwise inexplicable sudden deaths after fractures. Fat-embolism may arise during osteomyelitis, after extensive bruises, crushes, lacerations, amputations, fractures, resections, or rupture of the liver.\* In a fatal case of mine it developed as a result of manipulation of a fracture of the neck of the femur. In another fatal case it followed amputation for cancer of the breast of a very fat woman. This fluid fat accumulates especially in the capillaries of the lungs and brain. It may plug systemic capillaries. If the patient recovers, he does so because the fat has been forced through the vessels; if he dies, the death results from mechanical hindrance to function and nutrition. When the emboli are widely scattered and not large, and when they do not lodge in vital parts of the brain and cord they may produce no symptoms and do no real harm. Normal blood contains a small amount of finely emulsified fat (from I to 3 parts per 1000). In a number of physiologic and pathologic conditions the circulating blood contains considerable free fat. It may be found in a pregnant woman, a nursing baby, a fat individual, or in anyone during digestion.

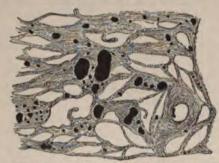


Fig. 95,—Fat-embolism of the lung after fracture of the femur. The fat-globules and masses, stained black with osmic acid, lie in the capillaries of the lung. × 150. (Hektoen.)

"It has been noted in the following conditions: chronic alcoholism; diabetes mellitus; certain diseases of the liver, heart, and pancreas; chronic nephritis; splenitis; tuberculosis; malarial fever, typhus fever; Asiatic cholera; and poisoning by phosphorus and by carbon monoxid. Lipemia commonly occurs as the result of lacerated wounds of the blood-vessels situated in fatty tissue, and after fractures of long bones involving injury of the fatty matter" ("Clinical Hematology," by John C. DaCosta, Jr.). In

many cases of fracture in adults fat is found in the urine. I have had this demonstrated by repeated observations. When we recall how rarely simple fracture causes death it becomes evident that a moderate amount of fat in the blood is not dangerous or only becomes dangerous if it fails to flow out. In lipemia fatty embolism may occur if the amount of fat becomes excessive or if vascular damage favors plugging. At my suggestion, Dr. Wm. Carrington conducted an investigation to determine the frequency of lipuria after fractures (Essay Awarded the Surgical Prize in Jefferson Medical College in 1908). He determined that fracture of long bones invariably causes lipuria, fracture of small bones seldom does; that after fracture of a long bone fat appears in the urine "on different days, in different amounts, and in different forms" (this curious periodicity was first observed

<sup>\*</sup> G. H. Makins, in Heath's Dictionary.

by Scriba, in 1878); that when fat is present albumin is almost always present and blood is occasionally found; that the urea percentage falls as the fat content rises and rises as the fat content falls; that the condition is rare in young children and that fat-embolism, as a rule, is a benign process; that about the fifteenth day after a fracture fat usually disappears from the urine. Carrington, in 1908, found in literature 276 reported cases of fat-embolism.

Symptoms.—Symptoms arise only when many emboli block a multitude of the capillaries of an organ, when a large embolism lodges, or when the capilbies of a vital region of the brain or medulla are blocked. The symptoms are those of edema of the lungs and exhaustion, often with coma or delirium, and sometimes, in the beginning, are wrongly thought to be due to shock. There are restlessness, dyspnea, rapid and weakening pulse, and rapid respiration, contracted pupils, and pallor followed by cyanosis. The temperature may be elevated, normal, or subnormal. Many coarse râles are heard in the chest, but percussion gives a clear note. If pulmonary edema becomes marked, the patient spitsup a bloody froth. If life is prolonged a day or two, oil is found in the wine. Small amounts of oil may be found in the urine after serious injuries or operations when no symptoms of embolism exist. Nevertheless, the presence of the oil is always a cause of anxiety and is often a warning. It is maintained by Groubé that the amount of fat in the urine is in inverse ratio to the amount in the blood; the greater the amount excreted in the urine, the less the amount retained in the blood. Hence, fat in the urine makes the surgeon anxious, and a sudden diminution of the amount in the urine is a sign of grave danger If there develops increasing difficulty in respiration ("Rev. de Chir.," July, 1895). The inverse ratio said to be maintained between fat in the blood and lat in the urine, if it really exists, is similar to a finding of Lépine in diabetes, that is, if a diabetic is given diuretics, the sugar in the urine increases and the sugar in the blood decreases. The symptoms of fat-embolism seldom occur until at least twelve hours after an accident, and rarely before the third day, but may occur as early as three hours. The symptoms occur at a later period than those of shock and at an earlier period than those of ordinary embolism of the lung. The important point emphasized by Carrington is that after the reaction from shock, if there were shock, and for hours or days after the mjury in any case, there is a period of freedom from all alarming symptoms, and that the symptoms of fat-embolism come on suddenly and without warning. I some of the oil is forced through the vessels of the lung, it will lodge in other regions and produce other symptoms. Oil may appear in the urine as above stated. Urinary suppression may occur. Delirium may arise, there may be witching, convulsions, or paralysis, or the patient may pass into coma. The eye-ground may show choked disk, hemorrhage, and fat in the vessels (Conactis case and Czerny's case). Cases of fat-embolism with severe symptoms are commonly fatal; milder cases are often recovered from. In mild cases the Juptoms last but a few hours, in severe cases the condition may prove fatal in from three hours to seven days after the injury, and in from twenty-four to lorty-eight hours after the appearance of symptoms. A patient may have two or three attacks, Connel's case had three attacks, there being an interval of a week between the first and second and between the second and third attacks.

Treatment.—The treatment consists in absolute rest of the diseased or injured part and the administration of stimulants, such as strychnin, alcohol,

and carbonate of ammonium, the use of external heat; the employment of oxygen by inhalation; and the administration of diuretics and of nitroglycerin hypodermatically. Artificial respiration may tide a patient over a crisis. If an external wound exists, free drainage must be established, and the diseased or damaged part should be thoroughly immobilized if possible. In order to prevent fat-embolism after a severe injury insist on rest. Massage used early after some injuries is dangerous, as it may force fluid fat into the vessels. When severe contusion causes the formation of a large cavity filled with blood, Groubé wisely advises incision, to lessen the danger of fat-embolism.\*

Air-embolism.—Air may enter a vein during a surgical operation or it may be injected accidentally while giving a hypodermic injection, hypodermoclysis, or a saline infusion into a vein. It may follow irrigation of the pleura with hydrogen peroxid. In caisson disease it is taught by some that nitrogen is set free in the blood. It may occur when a cerebral sinus is opened, or in the uterine veins, if the uterus does not remain contracted after delivery. It is very seldom that any symptoms follow. It was long thought that such an accident must be extremely dangerous. The experiments of my colleague, Professor Hare, indicate that quantities of air may be injected into the veins of a dog without apparent harm. The entry of a small amount of air into the veins of a human being will not be apt to induce dangerous symptoms, but it may be fatal. The more rapidly it is introduced and the greater the amount, the greater is the danger. The manner in which it can induce death is doubtful. Some maintain that it causes blood in the right side of the heart to froth, and thus prevents normal action of the valves, the heart becoming unable to propel blood through the lungs. Others maintain that air reaches the cerebral capillaries and so causes cerebral anemia. Some believe cardiac failure results from the presence of air in the pulmonary capillaries. The first view is the most probable. If a surgeon divides a large vein, air may be sucked in, and there is particular danger in such an accident if a vein at the root of the neck or a cerebral sinus is torn or incised, or if the damaged vessel lies in scar tissue and cannot collapse.

Symptoms.—When during an operation air enters a large vein there is a sucking sound, air bubbles may be noted in the wound, and serious symptoms may or may not follow. Twice I have wounded the subclavian vein and have heard this sound, but no alarming symptoms developed. If serious symptoms are produced, they arise suddenly, and consist of extreme failure of circulation, a curious whirring or churning sound on cardiac systole audible even without a stethoscope, deadly pallor or cyanosis, gasping for air, convulsions, and possibly death.

Treatment.—Compress the vein with the finger and clamp it quickly. Suspend the anesthetic, lower the head, employ artificial respiration, and give inhalations of oxygen, and strychnin hypodermatically.

<sup>\*</sup> Rev. de Chir., July, 1895.

## X. SEPTICEMIA AND PYEMIA.

Septicemia, or sepsis, is a febrile malady due to the introduction into the blood of pyogenic organisms or the products of pyogenic organisms or of saprophytic bacteria. There is no one special causative organism, and any microbe which produces inflammatory and febrile products may cause it. Either streptococci or staphylococci may be present. Pneumococci are a not very unusual cause. Septicemia arises by absorption of septic matter by the lymphatics. Clinically we distinguish two forms of septicemia: (1) sapremia, septic or putrid intoxication; and (2) septic infection, true or progressive septicemia. In these conditions the area of infection is usually discovered by the surgeon; but when it cannot be located, the disease is called by

the Germans cryptogenetic septicemia.

Sapremia, Septic or Putrid Intoxication.—This condition is due to the absorption of poisonous ptomains from a putrefying area. The bacteria do not enter the blood, but their toxins do, and, as these toxins are active poisons, the condition is comparable to poisoning by successive alkaloidal injections, the symptoms and prognosis depending upon the dose. Not unusually there is absorption not only of the toxins of saprophytic bacteria, but also the toxins of pyogenic micro-organisms. Even if some of the bactena enter the blood, they do not multiply in this fluid. Slight symptoms and recovery follow a small dose; grave symptoms and death follow a large one. The poison does not multiply in the blood, and a drop of the blood of a person laboring under putrid intoxication will not produce the disease when introduced into the blood of a well person; in other words, the disease is not infective. Considerable putrid material must be absorbed to cause sapremia. What is known as surgical fever is due to the absorption of a small amount of putrid or fermented wound fluid, and is in reality a mild form of sapremia. If sapremia arises, it does so soon after the infliction of a wound, and after a large rather than small wound, when a considerable amount of wound fluid is pent up under pressure. It may follow labor where putrid fluid is retained in the womb, may follow an injury of or an operation upon a joint, may follow amputation where decomposing blood-clot or wound fluid is pent up within the flaps, or may ensue upon an abdominal operation or injury. In sapremia there always exist a considerable absorbing surface and a large amount of dead matter which has become putrid. Roswell Park \* points out that sapremia arises from putrefaction of a blood-clot or wound fluids which are retained like foreign bodies in the tissues, and does not arise from putrefaction of the tissues themselves. He speaks of the condition as due to the absorption of poison from a "putrid suppository." Sapremia will not occur after granulations form. The term putrefaction is used because this is the usual change, but any fermentative organism may cause the disorder. Sapremia is a malignant form of surgical fever, and its existence means an ill-drained wound, and a fermenting and probably putrid collection of blood-clot or wound fluid.

In sapremia there is congestion of the stomach, intestines, and other abdominal viscera, particularly the kidneys, and also of the brain, and numbers

of red blood-cells disintegrate.

<sup>\* &</sup>quot; Treatise on Surgery by American Authors."

Symptoms.—The patient often seems to react incompletely from the injury; he feels miserable, complains of headache, nausea, and pain in the back and limbs; or, he may react and in a day or two develop this condition of malaise. In some cases an aseptic fever is directly succeeded by sapremia. In most cases of sapremia, between twenty-four hours and two or three days after labor, after an injury, or after an operation, there is a chill, or at least a chilly sensation, though in some cases this is wanting. The temperature rapidly rises to 103° F. or even more. There are severe headache, dry and coated tongue, rapid and weak pulse, nausea, and often vomiting, diarrhea, great prostration, restlessness, muscular twitching, and active delirium. The wound is found to be foul, and commonly there is drying up of wound discharge. There is diminution or suppression of urine, and a strong tendency to congestion of various organs. Jaundice is not unusual. Petechial spots are frequently noticed upon the skin. They occur also upon mucous membranes and serous surfaces, and result from the plugging of small vessels with detritus of brokendown red corpuscles and consequent vascular rupture. Great elevation of temperature often precedes death. In some cases the dose of poison is so large that the patient passes into rapid collapse without preliminary fever. Some cases recover if the initial dose is not overwhelming and if additional doses are not absorbed. Many cases die of exhaustion. Some become linked with fatal pyemia or septicemia. Hemoglobin and red blood-corpuscles are rapidly and notably diminished. Distinct leukocytosis exists, except in those cases in which the organism is overwhelmed with the poison and is unable to react. Cover-glass preparations do not show organisms, and cultures from the blood are sterile.

Treatment.—The treatment consists in at once draining and asepticizing the putrid area and administering very large doses of alcohol and large medicinal doses of strychnin and digitalis. The patient should be purged and diaphoresis favored. The hot bath is valuable to cause sweating. The action of the kidneys must be maintained if possible. Purgatives, diuretics, and diaphoretics are given to aid in removing the toxin, and stimulants are used to sustain the strength of the patient during the elimination of the poison. Vomiting is allayed by champagne, cracked ice, calomel, cocain, or carbolic acid with bismuth. Food should be administered every three hours. The patient is fed on milk, milk and lime-water, liquid beef-peptonoids, beefjuice, and other concentrated foods. Quinin in stimulant doses is of value. Antipyretics are useless. The use of saline fluid by hypodermoclysis or intravenous infusion dilutes the poison and stimulates the heart, skin, and kidneys to activity. Visceral complications must be watched for and should be promptly treated if discovered. Among the possible visceral complications are nephritis, cholecystitis, enteritis, hepatitis, peritonitis, pleuritis, empyema, bronchopneumonia, pericarditis, and endocarditis. Antistreptococcic serum is useless in sapremia.

Septic Infection, or True Septicemia.—This condition is a true infective process. In sapremia the blood contains toxins of putrefactive bacteria, but not the bacteria themselves. In septic infection the blood contains both pyogenic toxins and multiplying pyogenic bacteria, the bacteria perhaps being free in the blood or in white cells. In sapremia the causative condition is putrid material lodged like a foreign body in the tissues. In

septic infection the tissues themselves are suppurating, and both bacteria and toxins are being absorbed by the lymphatics. Of course, septic infection may be associated with septic intoxication or may follow it. In suppurative fever the tissues suppurate, but only the pyogenic toxins are absorbed, and not the pyogenic bacteria. In septic infection both the pyogenic bacteria and toxins enter the blood, and the bacteria multiply in the blood and produce continually increasing amounts of poison. The symptoms of sapremia depend on the dose. In septic infection only a small number of organisms may get into the blood, but they multiply enormously. The pus microbes cause true septicemia, and reach the blood chiefly through the lymphatics, but to some degree by penetrating the walls of vessels. A drop of blood from a man with septic infection will reproduce the disease when injected into the blood of an animal; hence the disease is truly infective. The wound in such cases is often small, but may be large, and is commonly punctured or lacerated, and the disease begins later after the infliction of a wound than does sapremia. No wound may be discoverable, the infection having arisen from an unrecognized focus of suppuration—for instance, gonorrhea, middle-ear disease, dental caries, tonsillar suppuration, appendicitis, etc. Septicemia in which the initial atrium of infection is not discovered is called cryptogenetic septicemia.

The bacteria which exist in the blood and organs in septicemia are usually staphylococci or streptococci, often both. Pneumococci or colon bacilli in some cases are causative. The blood is found to have lost much of its coagulating power; it remains fluid for some time after death, quantities of red corpuscles are destroyed, and minute hemorrhages take place in the brain, mucous membranes, skin, serous membranes, muscles, and various viscera. There may be inflammation of synovial and serous membranes. There is congestion of the gastro-intestinal tube and of the abdominal viscera. The lymph-glands are larger than normal and the spleen is notably enlarged. The wound contains numbers of bacteria.

Symptoms.—The type of this condition is met with in puerperal septicemia ur in septicemia from an infected wound. When septicemia arises from an infected wound, red lines due to lymphangitis are usually seen about the wound, and there is enlargement of related lymphatic glands. In some cases, however, the wound and the parts about it look normal. A supposed aseptic lever after an injury may continue for an undue time and the surgeon may and that septicemia has developed. Septicemia may arise during the exisbroce or after the abatement of sapremia, or may arise when the aseptic fever has passed away and when there has been no putrid intoxication. It begins in from four to seven days after labor or an injury, usually with a chill, which s followed by fever, at first moderate, but soon becoming high. In some there is a chilly sensation, but no distinct chill. There is always great prostration even before the chill. The fever presents morning remissions and evening exacerbations, and may occasionally show an intermission. When the remission begins there is a copious sweat. As the case progresses the temperature may fluctuate, and it often rises very high before death. The pulse is small, weak, very frequent, and compressible. The tongue is dry and brown, with a red tip. Sordes gather on the teeth and gums. Vomiting is frequent, and, as a rule, there is diarrhea. Low delirium alternates with stupor, and coma is usual before death. The great prostration is a noticeable and characteristic feature of the sufferer from septicemia. There are subsultus tendinum (twitching of the muscles of the hands and feet) and carphologia (picking at the bedclothing). Toward the end the face often becomes Hippocratic (hollow temples, pinched nose, sunken eyes, livid skin, lead-colored and cold ears, and relaxed lips). Visceral congestions occur. The spleen is enlarged, ecchymoses and petechiæ are noted, urinary secretion becomes scanty or is suppressed, and the wound becomes dry and brown. Blood-examination detects a rapid and great diminution in red corpuscles and hemoglobin. The anemia is in many cases profound. There is marked leukocytosis except when the system is overwhelmed by the poison. Cover-glass preparations made from blood may show bacteria, but often fail to do so. Cultures from the blood are sterile in most cases, but not in all. A negative finding does not disprove the existence of septic infection; a positive finding is of conclusive diagnostic value. Pneumococcic septicemia is extremely violent in manifestation. In some cases death ensues before the lung has consolidated. If it is not so rapid endocarditis, arthritis, peritonitis, meningitis, or osteomyelitis may develop.

The prognosis of true septicemia is very unfavorable, and in some malignant cases death occurs within twenty-four hours, but mild cases often recover. Welch points out that finding the staphylococcus pyogenes albus in the blood is not particularly ominous, but the presence of other pyogenic cocci is exceedingly threatening. Endocarditis, pericarditis, peritonitis, pleuritis, bronchopneumonia, empyema, nephritis, arthritis, cholecystitis, hepatitis, meningitis,

and pyelitis are among the complications which may arise.

Treatment.—The treatment in general is the same as for septic intoxication. Antistreptococcic serum is employed by some surgeons, but the value of this method is as yet doubtful. It does not do any harm. It may do good. It is proper to use it, but not to the exclusion of other remedies. The usual dose is 10 c.c. injected into the abdominal wall. The injection may be repeated two, three, or even six times a day, and may be used for a number of days. Because of uncertainty as to the causative organisms polyvalent serum is used by some. Some use bacterial vaccines. Petre has injected fresh warm horse serum to stimulate leukocytosis. Jayle ("La Presse médicale," 1905, p. 722) and Federman have also used it. All sera and vaccines are as yet of undetermined value in septic infection. Washing the blood by the intravenous infusion of salt solution often produces distinct improvement, which, unfortunately, is usually temporary. Dr. C. C. Barrows commends formalin used intravenously. The strength of the solution is 1 part of formalin to 5000 parts of salt solution. The dose is 500 cc. I have had no experience with formalin in septicemia, but do not believe that any reagent can be safely introduced which would rapidly and directly kill the bacteria. Even if such an agent could be found, the attempt to use it would be dangerous, as dead bacteria liberate a poison, and the rapid death of immense numbers of bacteria would mean the entrance into the blood of an enormous amount of toxic matter.

Pyemia.—Pyemia is a condition in which metastatic abscesses arise as a result of the existence of septic thrombophlebitis, the disease being characterized by fever of an intermittent type and by recurring chills. It is not actually due to free pus in the blood, but to the passage into the blood of

clots filled with toxins or, far oftener, of clots infected by streptococci, staphylococci, or both. After a wound is inflicted blood clots in the divided veins. If suppuration occurs, the clots may become filled with the toxins of pyogenic bacteria or be invaded by the bacteria themselves. Thus it becomes evident that pyemia may develop with septicemia. It may also develop when there is suppuration in a wound, but not septicemia, no lymphatic absorption of bacteria or toxins having occurred. A suppurating focus about a vein may cause thrombophlebitis and clot-formation even when no wound exists. This is seen in thrombophlebitis of the lateral sinus secondary to suppuration of the middle ear.

A vessel thrombus runs up in the lumen of a vein, and the apex of the dot softens, a portion of it is broken off by the blood-stream and carried as an embolus into the circulation. Many of these poisonous emboli enter into the blood and lodge in some vessels which are too small to transmit them, and at their points of lodgment form embolic, secondary, or metastatic abscesses. If the embolus contains only pyogenic toxins the danger is infinitely less than if it contains bacteria. The secondary abscess if caused by a clot containing only toxins may not lead to further dissemination of disease. If the embolus contains bacteria, thrombophlebitis occurs about it, and new infected emboli form and are sent throughout the system. Wounds of the superficial parts and bones produce pyemic infarctions and metastatic abscesses of the lungs. When these infarctions break into fragments particles may return to the heart and lodge, or may be sent out through the arterial system to form other foci in distant organs. Infected areas connected with the portal circulation (intestinal injuries or suppurating piles) may produce abscess of the liver. Wounds of bones which open the medullary cavity or diploic structure are particularly apt to be followed by pyemia, and the disease may follow labor, phlegmonous erysipelas, and other conditions. Malignant endocarditis is called "arterial pyemia," and is due to endocardial embolic infection. In this disorder infected emboli lodge in the kidneys, the spleen, the alimentary tract, the brain, or the skin (Osler). Idiopathic pyemia is a misnomer. Some primary focus of infection must exist, as was pointed out when discussing septicemia.

Symptoms.—The wound often becomes dry and brown, and sometimes also offensive. A severe and prolonged chill or a succession of chills ushers in the disease; high fever follows, and drenching sweats occur. The chills recur every other day, every day, or oftener. A chill arises from the liberation and lodgment of emboli. During the sweat the temperature falls and may become nearly normal, normal, or actually subnormal. The temperature often oscillates violently. The general symptoms of vomiting, wasting, etc, resemble those of septicemia. In some cases the mind remains clear, in many the delirium is purely nocturnal. The skin frequently becomes jaundicel and a profound adynamic state is rapidly established. thanges are like those of septicemia. The spleen is enlarged. The lodgment demboli produces symptoms whose nature depends upon the organ involved. lodgment in the lungs causes shortness of breath and cough, with slight physial signs. Lodgment in the pleura or pericardium gives pronounced physical widence. Lodgment in the spleen produces severe pain and great enlargement. The parotid gland not unusually suppurates.

In a suspected case of pyemia always examine an existing wound, and if there is no wound, remember that the infection may arise from gonorrhea, osteomyelitis, suppuration in the middle ear, appendicitis, dental caries, tonsillar suppuration, abscess of the prostate, etc. Chronic pyemia may last for months; acute pyemia may prove fatal in three days. The chief complications are joint-suppuration, bronchopneumonia, pleuritis, empyemia, endocarditis, pericarditis, peritonitis, nephritis, cholecystitis, pyelitis, venous thrombosis, and abscesses.

Treatment.—The treatment is the same as for septicemia. Open, drain, and asepticize any wound and any accessible secondary abscess. The remarks made as to the use of sera and bacterial vaccines in septicemia apply also to

pvemia.

Erysipeloid (reticular lymphangitis, crab cellulitis) was described by Rosenbach in 1887, although like cases were reported nearly fifteen years before by Morrant Baker under the name of erythema serpens. Gilchrist, in 1904. reported 329 Baltimore cases. I have seen a number of cases in the Jefferson Hospital. The condition is due to infection from handling putrid animal matter, especially fish; bites of crabs, and sticks of fish fins. Rosenbach claimed to find a special organism resembling but larger than a staphylococcus. but other observers fail to find it. The period of incubation is from a few hours to two days. Jopson describes the disease as follows ("American Jour. Med. Sciences," May, 1908): "It appears as a swelling with elevated, sharply defined edges, which soon affects the entire circumference of the finger; and is commonly described as of a dark-red color, with purplish or even livid edges. The finger is tense and only moderately painful, but itching and burning are prominent symptoms. Sections of tissue excised show an inflammation of the entire corium and, to a slight extent, of the subcutaneous tissue, with infiltration of polynuclear leukocytes and small lymph-cells; edema of the epithelial cells of the epiderm; and inflammatory changes, especially marked around the sweat-glands and blood-vessels (Gilchrist). It has a characteristic tendency to spread from its usual point of origin, near the end of the finger, toward the palm, the primarily affected area fading from red to yellow, and thence to normal. Reaching the palm, it may spread over it; but commonly, it soon affects the neighboring finger; and, when untreated, it may gradually spread to all the fingers and to the back of the hand. There is no fever or other constitutional disturbance, and the lymph-glands are almost never involved. It is more or less self-limited, commonly lasting from ten days to three weeks; and during this time there is a well-marked tendency to relapse. There is no suppuration, pustulation, or vesiculation, and no scaling follows."

It is treated by applications of lead-water and laudanum, ichthyol or compresses soaked in a saturated solution of Epsom salt. Jopson applies tincture

of iodine and Gilchrist 25 per cent. salicylic acid plaster.

## XI. ERYSIPELAS (ST. ANTHONY'S FIRE).

Erysipelas is an acute, contagious, spreading capillary lymphangitis due to the streptococci of erysipelas, which grow and multiply in the smaller lymph-channels of the skin and its subcutaneous cellular layers and also in the lymph-channels of serous and mucous membranes. Cutaneous erysipelas is characterized by a rapidly spreading dermatitis, by a remittent fever due to absorption of toxins, and by a tendency to recurrence. It is always preceded by a wound, a scratch, or an abrasion, which may have been trivial and may never have been noticed. The so-called idiopathic erysipelas is preceded by a breach of surface continuity so small as to escape notice. The initial point of infection may be in the mouth, the nostril, the pharvnx, the auditory meatus, between the fingers or toes, at the margin of a nail, or in a cutaneous furrow. The involved area in cutaneous erysipelas seldom suppurates but sometimes does, very thin or watery pus being formed. If thick pus forms it means mixed infection with staphylococci, but the formation of thin pus does not require a mixed infection, as the streptococcus is identical with the streptococcus pyogenes. In some cases of erysipelas, staphylococcus infection follows and even actually replaces streptococcus infection. The rapid spread of erysipelas is due to the fact that the streptococci prevent coagulation of exudate and are not actively attacked by leukocytes. Erysipelas s most common in the spring and fall, and is most usually met with among those who are crowded into dark, dirty, and ill-ventilated quarters; it attacks by preference the debilitated and broken-down (as alcoholics and sufferers from Bright's disease). The disease may become endemic in special places or localities. The poison of erysipelas will produce puerperal fever in a lyingin woman. The streptococcus was first obtained in pure cultures by Fehleisen. This organism is widely diffused. The question of identity with the streptococcus pyogenes is discussed on page 48.

Forms of Erysipelas .- Ambulant, erratic, migratory, or wandering erysipehas is a form which tends to spread widely over the body, leaving one part and going to another. Bullous erysipelas is attended by the formation of bullæ. In diffused erysipelas the borders of the inflammation gradually merge into healthy skin. Erythematous erysipelas involves the skin superficially. Metadalic erysipelas appears successively in various parts of the body. Puererysipelas begins in the genitals of lying-in women, producing puerperal ferer. Erysipelas simplex is the ordinary cutaneous form. Erysipelas ntonatorum begins in the unhealed navel of a newborn child and spreads from this point. Typhoid erysipelas occurs with profound adynamia. Unitotal erysipelas involves the entire body. Cellulitis is often erysipelas of the unbcutaneous layers. Phlegmonous erysipelas involves the skin and the cellular tissues, and causes suppuration, and often gangrene. Edematous trisipelas is a variety of phlegmonous erysipelas with enormous subcutaneous tdema. Lymphatic erysipelas is characterized by rose-red lines due to lymphangitis. Venous erysipelas is marked by the dark color of venous congestion. Mucous erysipelas involves a mucous membrane. Erysipelas may attack the fauces, producing the very grave condition known as faucial erysipelas.

Clinical Forms.—The clinical forms are cutaneous erysipelas, cellulocutaneous or phlegmonous erysipelas; cellulitis, and mucous erysipelas.

Cutaneous erysipelas most frequently attacks the face. A fever suddenly appears, rises rapidly, reaches a considerable height, is remittent in type and sometimes distinctly fluctuating, and usually terminates in four or five days by crisis. At the time of febrile onset spots of redness appear on the skin. These spots run together, and soon a large extent of surface is found to be red and a little elevated. Any wound, ulcer, or abrasion which exists becomes dry and unhealthy, and its edges redden and swell. The erysipelatous area of redness and swelling extends either in spots with intervening healthy skin or in an uninterrupted line. The margin is usually sharply defined from the healthy skin, and the color fades at the original focus as the disease advances at the periphery of the red area. The color fades at once on pressure and returns at once when pressure is removed. There is slight burning pain, which is increased by pressure. In the hyperemic area vesicles or bullæ form, containing first serum and later it may be sero-pus, but there is rarely genuine suppuration in cutaneous erysipelas. Edema affects the subcutaneous tissues, producing great swelling in regions where there is much loose cellular tissue (as in the eyelids). The anatomically related lymphatic glands may become large and tender. In an ordinarily strong person the color of an erysipelatous area is bright red or more rarely dark red. A dusky color precedes suppuration. A blue color precedes gangrene or indicates profound cardiac and pulmonary involvement. Erysipelas spreads now in one direction, now in another, influenced, according to Pfleger, by the furrows of the skin. When the disease ceases to spread, the swelling and redness gradually abate, and after they disappear desquamation takes place, and the blebs become dry and crusted.

In strong subjects the constitutional symptoms of cutaneous erysipelas are usually slight. In the old and debilitated the symptoms are typhoidal, there is a dry tongue, dyspnea, and hebetude, delirium comes on, and death is usual. Possible complications are meningitis, pneumonia, septicemia, pleuritis, pyemia, endocarditis, arthritis, and albuminuria. Erysipelas neonatorum is generally fatal. In some instances an attack of erysipelas will cure an old skin eruption, a new growth, an ulcer, or an area of lupus. This is the éry-

sipèle salutaire of our French confrères.

Treatment.—Isolate the patient, asepticize the wound, if there be a wound, and administer a purge. Cases of cutaneous erysipelas occurring in a fairly healthy, young or middle-aged subject, tend to get well without treatment. If a person is debilitated, free stimulation is necessary. Tincture of chlorid of iron is usually administered in doses of from 20 to 40 m three times a day. Tonic doses of quinin are also given. Nutritious food is given at intervals of three or four hours. For sleeplessness or delirium use chloral or the bromids; for very high temperature, cold sponging is required. To prevent spreading some have advised injection of the healthy skin near the blush with a 2 per cent. carbolic solution or with fluid containing gr. \frac{1}{16} of corrosive sublimate. A band of iodin painted on the skin may arrest the progress of the disease, and so may a ring streaked around a limb or about an erysipelatous area by lunar caustic. Kraske has suggested a method of preventing the

spread of cutaneous erysipelas which is often effective. The patient is anesthetized. At about two inches from the margin of the redness a series of cuts are made into the skin, to a sufficient depth to cause free oozing. Each cut is crossed by another cut and a ring of scarifications is made to surround the region of the erysipelas. After the oozing ceases the scarified area is soaked for one hour with a solution of carbolic acid (1:20) or corrosive sublimate (1:2000). The part is dressed with pads wet with carbolic acid (1:40) or corrosive sublimate (1:2000). This operation causes the formation of a protective barrier of leukocytes. Locally, paint the inflamed area with equal parts of tincture of iodin and alcohol and apply lead-water and laudanum. The iodin is germicidal and quickly enters the lymph-spaces. The leadwater and laudanum allays the burning pain. If an extremity be involved, bandage it. Some advocate a daily inunction of Credé's soluble silver. A good application is a 50 per cent. ichthyol ointment with lanolin. A very useful method is von Nussbaum's. The author applies it somewhat modified, as follows: wash the part with ethereal soap, irrigate with a solution of corrosive sublimate (1:1000), dry with a sterile towel, apply an ointment of ichthyol and lanolin (50 per cent.), and dress with antiseptic gauze. we iced-water cloths. Hot fomentations are distinctly harmful. Some apply borated talc or salicylated starch. Ringer advised painting every three hours with a mixture composed of gr. xxx of tannic acid, gr. xxx of camphor, and 3iv of ether. J. M. DaCosta recommended pilocarpin internally in the beginning of a case. The Bier treatment is often useful. Antistreptococcic srum has been used in erysipelas, and most beneficial results have been claimed for it. It is asserted that under its influence the temperature soon becomes normal. My personal experience with the serum treatment has not convinced me of its value, although some cases seem to be benefited. Schorer studied 100 cases of erysipelas in Bellevue Hospital and determined the opsonic index and its relation to treatment by inoculation of dead streptococci. He concluded that the vaccine does not prevent migration or recurrence, but seems to shorten the duration of the disease ("Amer. Jour. Med. Sciences," Nov., 1907). Ross and Johnson regard treatment by a specific vaccine as very efficient ("Jour. Am. Med. Assoc.," March 6, 1909).

Cellulocutaneous or phlegmonous erysipelas is characterized by high temperature (104°-106° F.), the rapid onset of grave prostration, irregular chills, sweats, and a strong tendency to delirium. The constitutional condition may be one of suppurative fever, sapremia, septicemia, or pyemia. The parts are red, as in cutaneous erysipelas, and the tumefaction is vastly greater. The swelling is brawny, comes on early, increases with exceeding rapidity, induces a high degree of tension, and frequently becomes associated with sloughing or even cutaneous gangrene. The lymphatic glands are swollen, but the inflamed lymphatic vessels are hidden by the tumefaction. In most cases suppuration occurs, and when this happens the parts become boggy and the law is widely disseminated in the subcutaneous and intramuscular tissues, and even into muscle-sheaths and tendon-sheaths (purulent infiltration). When the disease abates sloughs form, which leave ulcers upon being cast off. In had cases muscles, vessels, tendons, and fascia may slough away. The commonest complications are suppression of urine, bronchopneumonia, con-

gestion and edema of the lungs, meningitis, congestion of the kidneys, and acute pleurisy. Septicemia or pyemia may occur. We sometimes meet with this form of erysipelas after extravasation of urine. It is not a pure streptococcus infection. There is a mixed infection with other pyogenic cocci, and

often with organisms of putrefaction.

Treatment.—At once asepticize and drain any existing wound, and dress such a wound with hot antiseptic fomentations. If there are inflamed lymphvessels or glands above the area of cellulocutaneous infection, paint the skin above them with iodin and smear it with blue ointment or rub in Credé's ointment of soluble silver. Make numerous incisions into the inflamed tissues. These incisions should be near together, and each cut should be two or three inches long. Spray the wounds with hydrogen peroxid by means of an atomizer, wash with corrosive sublimate solution (1:1000), and pack each wound with iodoform gauze. Dress with many layers of gauze wet with a hot solution of corrosive sublimate. The gauze is covered with a rubber dam and a hot-water bag is laid upon the dressing. If sloughs form, cut them away and employ hot antiseptic fomentations. Change the dressings often. In



Fig. 96.-Acute cellulitis of palm and forearm following a slight wound.

some cases it may be necessary to employ continuous irrigation with warm antiseptic fluid, or continuous immersion in a hot aseptic or antiseptic bath. It is not unusually necessary to operate for the removal of enlarged lymphatic glands. The Bier treatment is a valuable addition to our resources. In rare cases amputation is demanded. When granulations begin to form, treat as a healing wound. The constitutional treatment is that previously set forth as applicable to septicemia, viz., purgation, the use of diuretics and diaphoretics, the administration of strychnin, quinin, digitalis, alcoholic stimulants, and nourishing food. In severe cases employ hypodermoclysis or saline infusion into a vein. Antistreptococcic serum may be employed.

Cellulitis.—Cellulitis (Fig. 96) is a microbic inflammation of the cellular tissue. It may be due to staphylococci, to streptococci, to other pyogenic bacteria, or to mixed infection with two varieties of pyogenic organisms. The

commonest form is streptococcus infection, and this is a variety-of erysipelas. A streptococcus infection may be followed and replaced by a staphylococcus infection. Infection with the Bacillus aérogenes capsulatus causes gangrenous cellulitis. Cellulitis is prone to arise in damaged tissues, for instance, in a crushed part, a limb the seat of a compound fracture, or tissue containing extravasated urine. In tissue the resistance of which has been lessened by diabetes, Bright's disease, irritating discharges, or trophic lesions, cellulitis s rather apt to develop. In cellulitis of the subcutaneous tissue the microorganisms find entrance by means of a wound. Swelling precedes redness. The swelling is not so marked as in phlegmonous erysipelas, and the redness is darker and is less distinct than in cutaneous erysipelas. The redness of cellulitis is about the wound; it spreads but does not fade at the center as does ordinary erysipelas; red lines due to lymphangitis ascend the limb from the infected wound, and the anatomically associated lymphatic glands enlarge. In the wound and its neighborhood there is severe throbbing pain. The constitutional symptoms of infection develop rapidly. In trivial cases the lymphatics dispose of the poison and suppuration does not occur. In severe cases pus forms about the wound and lymphatic glands may suppurate. Phlegmonous erysipelas may develop, and septicemia or pyemia may arise.

Treatment.—Open, disinfect, and drain the wound. Paint iodin upon the skin over inflamed lymphatic vessels and glands and cover with ichthyol ointment or rub Credé's soluble silver ointment into the skin over the inflamed lymph-glands and vessels. Dress the wound and the adjacent inflamed area with hot antiseptic fomentations. Secure rest of the part. It may be necessary to make incisions as in phlegmonous erysipelas. In some cases it is necessary to remove breaking-down glands. The constitutional treatment is that employed for septicemia.

## XII. TETANUS, OR LOCKJAW.

TETANUS is a microbic disease invariably preceded by some injury and characterized by spasm of the voluntary muscles. The wound may have been severe, it may have been so slight as to have attracted no attention, it may have been inflicted upon the alimentary canal by a fish-bone or other foreign body, or may have been situated in the nose, urethra, vagina, or ear. It is possible that infection can occur through a mere abrasion of a mucous membrane. The so-called idiopathic tetanus is either not tetanus at all, or the term expresses the fact that we have not found the traces of an injury which did exist. Tetanus arises most frequently after punctured and particularly after lacerated wounds of the hands or feet. In a surgical experience of over twenty years in connection with the Philadelphia Fire Department I have known hundreds of firemen to injure their feet by stepping on nails and not one developed tetanus. In fact, the only case of tetanus among them since 1871 arose in a man who lacerated his hand with glass. Before tetanus appears a wound is apt to suppurate or slough; but in some instances the wound is found soundly healed when the tetanus begins. The toy pistol produces a peculiarly dangerous wound. In the United States many cases of tetanus follow the celebration of the Fourth of July, a large per cent. of

the causative wounds being from the toy pistol. The Fourth of July, 1903, was responsible for 466 reported and no one knows for how many unreported cases in the United States. Since that date the prophylactic use of antitetanic serum has become the rule of practice in suspected injuries and there has been a notable diminution in the number of cases. The fact that the bacillus of tetanus is anaërobic explains the comparative frequency with which punctured and lacerated wounds are attacked, for in such wounds the bacilli are deeply lodged in recesses or cavities into which air does not penetrate or are covered with discharges which exclude air. Suppuration favors the growth of tetanus bacilli because the pyogenic organisms consume oxygen. Occasionally, though fortunately very rarely, tetanus follows vaccination. It is essential that vaccine virus should be carefully selected and prepared. When care is taken, the operation is absolutely safe. When tetanus follows vaccination, it arises from infection of the wound either at the time of vaccination or, as is far more common, at a later period from scratching or some other fouling. The tetanus organism is not introduced in the vaccine, but obtains entrance during or subsequent to the operation of vaccination because of utter neglect of the vaccine lesion and in consequence of the accumulation of filth upon and about it. In no reported case have the symptoms of tetanus appeared earlier than two weeks after vaccination (Wm. N. Welch, "N. Y. Med. Jour.," Jan. 16, 1909). The organisms or its spores have never been discovered in tubes or in points, and, as Rosenau points out, the organism cannot grow and cannot form toxins on dry points or in glycerinated virus. The most scrupulous care is taken to prevent contamination of vaccine virus and it is examined for tetanus toxin and tetanus bacilli before it is placed on the market. Tetanus has followed the injection of gelatin. Commercial gelatin often contains the bacilli and should never be used without careful fractional sterilization (page 420). Tetanus has followed a burn, a frost-bite, a hypodermatic injection of quinin, child-birth, abortion, and the use in a wound of contaminated catgut. Tetanus may appear within twentyfour hours after an accident, but it may not arise until many days or even several weeks have elapsed. Rose reported a case which began within twentyfour hours. Kuhn ("Berliner klinische Wochensch.," 1901) reports a fatal case of tetanus beginning twelve hours after an injection of gelatin. Such a rapid case could only be due to the gelatin having contained a large quantity of tetanus toxin (Schuckmann). Samuel D. Gross, in his "System of Surgery," speaks of one case occurring in a man five weeks after injury, and another in a girl four weeks after inujry. Jacobson and Pease are of the opinion that "such cases as have been recorded with periods of incubation under three days must be accepted with considerable reserve" ("Annals of Surgery," Sept., 1906). Tetanus prevails more in certain localities than in others, but it is met with all over the world from the Arctic Zone to the Tropics, and may arise in either sex, in any race, and at any age. Colored people are very susceptible, and the disease may exist endemically, and does so in certain portions of New Jersey and of Cuba. In our country the greatest prevalence, according to Anders, is in Pennsylvania, Northern New York, Long Island, Virginia, Georgia, and Louisiana. Anders collected 1201 cases and Pennsylvania stands first on his list with 224 cases ("Jour. Am. Med. Assoc.," July 29, 1905). It is stated that in certain districts of Nigeria the soil contains so many tetanus spores that the

natives poison their arrows by sticking them into the ground (Allan C. Parsons in Brit. Med. Jour.," Jan. 23, 1909). Tetanus is due to the growth in a wound of a bacillus which was first described by Nicolaier and was first cultivated by Kitasato. It is the most widely distributed of all the pathogenic bacteria. It is very difficult to cultivate and cannot be cultivated at all unless air is absolutely excluded. Tetanus bacilli or their spores are found particularly in garden soil, in the dust of walls, walks, and cellars, in street dirt, and in the refuse of stables. There is much suggestive evidence that virulent tetanus bacilli come from the intestinal canal of animals; that the bacteria lose their virulence when they have been long outside of the intestinal canal; and that the highest degree of virulence is obtained by those which have passed frequently through intestinal canals. The above view is known as the fecal theory and is strongly advocated by Somani.\*

It is taught that in tetanus the bacilli do not enter into the blood, and toxic products produced by them are not directly absorbed by the blood or lymph. Dr. Porter, of Boston, tells me that in a recent case he found bacilli in adjacent lymph-glands, a highly important observation. The toxic products alone without any bacteria enter the muscular end organs of motor nerves, ascend within the nerves, and reach the spinal cord and medulla (Brunner, Marie), become fixed in the nerve-cells of the spinal cord and medulla, and produce the symptoms of the disease. Hence tetanus is an intoxication and not an infection, and a drop of blood of an animal with tetanus, if injected into another animal, will not produce the disease. Tetanus toxin poisons the nervous system as would strychnin or some other vegetable alkaloid. It is probably the most powerful of known poisons. It has been estimated that  $\frac{1}{278}$  of a grain is sufficient to kill an adult weighing 165 pounds ("American Medicine," Nov. 30, 1901). The great power of the poison is shown by the report of Dr. Nicholas's case ("Comptes rendu de la Société de Biologie," 1803). Dr. Nicholas had been using a syringe to inject filtered cultures of the bacilli of tetanus and he accidentally pricked his finger with the needle. In four days tetanus began, and he barely escaped with his life in spite of the fact that the fluid was free of bacteria and the dose of toxin was extremely minute. The nature of the virulent poison which is produced at the seat of inoculation is uncertain. Some believe it to be alkaloidal, like the vegetable alkaloids; some that it is a toxalbumin; others maintain that it is an enzyme or ferment (Nocard, Courmont, and others). In a very few instances the injection of perfectly sterile antidiphtheritic serum into human beings has caused death with all the symptoms of tetanus. The serum must have been obtained from horses in whom tetanus was incubating, and the blood-serum injected must have contained a fatal dose of tetanus toxin. In tetanus an ascending neuritis occasionally, though seldom, exists in the peripheral nerve near the lesion. The toxin is carried to the cord by the motor nerves only, and it is not only absorbed by the lymph-channels of the nerve, but ascends along the axis-cylinders of the nerve itself and reaches the motor cells of the spinal cord (Meyer and Ransom, in "Arch. exper. Path. u. Pharmakol.," 1903). On reaching the cord it attacks the motor nerve-cells, producing changes similar to those involved in certain infections, and ascends in the motor tracts of the cord to

<sup>\* &</sup>quot;Verhandl. d. 10. internat. med. Cong.," Berlin, 1890, Bd. v, Abth. 15, p. 152.

the medullary nerve-centers. While toxin is ascending the axis-cylinders a certain amount is taken up by the lymphatics, enters the blood, and reaches the spinal cord by other nerve-fibers (Jacobson and Pease, in "Annals of Surgery," Sept., 1906). The essential basis of tetanus is spreading irritation of the motor portion of the spinal cord accompanied by extreme reflex excitability which is due to poisoning of sensory neurones (Meyer and Ransom). The irritation of the motor cord produces tonic contraction of the muscles; the excitation of the sensory neurones is responsible for clonic convulsions. There are no instances on record of second attacks of lockjaw, but it is not believed that one attack confers any prolonged immunity.

Local Tetanus.—In some cases local symptoms precede widespread evidences of tetanus. Experimental tetanus in animals "exhibits almost without exception as its earliest manifestations those of a purely local character and which are at first restricted to the neighborhood of the inoculation. This is now understood to be due to the absorption of the toxin by the motornerve of the part. The conditions favoring the local appearance of tetanus are a short motor nerve as in head injuries; an injury to a nerve-trunk permitting the rapid absorption of a large amount of toxin; the production of a meager amount of toxin or the presence of something which prevents the admission of a large amount of toxin into the circulation (Nathan Jacobson and Herbert D. Pease, in "Annals of Surgery," Sept., 1906). Cases with local symptoms in the beginning are apt to have had long periods of incubation, are apt to be cured, and usually endure a considerable time.

Symptoms.—Acute tetanus begins within ten days of an accident. The usual period of incubation is from three to five days. In most cases the first symptom is stiffness of the jaw on opening the mouth. In some cases the first symptom is stiffness of the neck, and the patient believes he has "caught cold." In any case the neck soon becomes stiff, and finally both the neck and jaw become as rigid almost as iron. The fixation of the jaw is called trismus. The muscles of deglutition become rigid on attempts at swallowing. The muscles of the back, legs, and abdomen are thrown into tonic spasm, but the arms rarely suffer. If the infected injury is on the hand or foot, that extremity usually is found to be rigid. Spasm of the face muscles causes the risus sardonicus, or sardonic smile (contraction particularly of the musculus sardonicus of Santorini). The contraction of the muscles of the back is often so powerful as to bend the patient into a curve like a bow and allow him to rest only on his occiput and heels. This condition is known as o pisthotonos. If he is bent forward, so that the face is drawn to the legs, it is called emprostholonos. If his body is curved sideways, it is designated pleurostholonos. An upright position is orthotonos. The spasm may be so violent as to cause muscular rupture.

The characteristic condition in tetanus is one of widely diffused tonic spasm, aggravated frequently by clonic spasms arising from peripheral irritations. These irritations may be draughts, sounds, lights, shaking of the bed, attempts at swallowing, contact of the bed-clothing, the presence of urine in the bladder or of feces in the rectum, or various visceral actions. The clonic spasms begin early in the case and become more frequent and more violent as the disease progresses. The muscles become more rigid and the attitude

produced by the tonic contraction of the muscles is temporarily exaggerated. The forcible contraction of the jaw may loosen or break teeth. The spasms of the diaphragm, of the glottis, and of the muscles of respiration may produce death and always produce great dyspnea. The man laboring under a tetanic convulsion presents a dreadful picture; he is bent into some unnatural attitude, the face is cyanotic and wet with drops of sweat, the lips are covered with froth which is often bloody, the eyes bulge and are suffused, and the countenance expresses deadly terror and suffering. The agonizing "girdle pain" so often met with is due to spasm of the diaphragm. Each clonic spasm causes a hideous scream by the constriction of the chest forcing air through a contracted glottis. During the progress of the disease constipation is persistent, and retention of urine is the rule (because of sphincter spasm). The mind is almost invariably entirely clear until near the end-one of the worst elements of the disease. In very rare cases delirium arises. I have seen it twice, due, I fancy, in each case to the drugs employed. It might, of course, be due to previous alcoholism. Swallowing in many cases is impossible. Talking is very difficult and it is impossible to project the tongue. The muscles throughout the body feel very sore. The temperature may be normal, but it is usually a little elevated, and always arises just before death. Hyperpyrexia sometimes occurs (108°-110° F.), and the temperature may even ascend for a time after death. Insomnia is obstinate. In about 80 or 85 per cent. of cases of acute tetanus death occurs within five days, and many of these patients die within two or three days. Very few puerperal cases recover and practically no cases which follow abortion recover. Of late years the mortality in acute tetanus has slightly diminished. If a patient lives a week, his chance of recovery is good. Death may be due to exhaustion or to carbonic-acid narcosis from spasm of the glottis or fixation of the respiratory muscles.

Chronic tetanus comes on late after a wound (from ten days to several weeks). The symptoms are not so severe as in acute tetanus. The muscular pasm is widespread, but it may not be persistent, intervals of relaxation permitting sleep and the taking of food. Chronic tetanus long had a mortality of 40 or 50 per cent., but modern methods of treatment, it has been claimed, have considerably reduced it. According to the report of Jacobson and Pease it is still from 35 to 50 per cent. ("Annals of Surgery," Sept., 1906). The disease may last for some weeks. Trismus neonatorum, or trismus nascentium, the lockjaw of the newborn, is due to microin of the stump of the umbilical cord, and is practically invariably latal. Hydrophobic tetanus, head tetanus, or cephalic tetanus, is a condition in which the spasms are confined chiefly to the face, pharynx, and neck, although the abdominal muscles are usually also rigid, and in which there is palsy of the seventh nerve. It follows head-injuries, and gives a better prognosis than does general tetanus.

Two other forms of tetanus have been produced in animals by experimenters. One is cerebral tetanus, produced by injecting tetanus toxin into the brain and characterized by mental symptoms (Roux and Borrell, in "An-

hals Ins. Pasteur," July, 1897). Another is tetanus dolorosa, produced by injecting toxin into the posterior roots of the spinal nerves, and characterized

by violent spasms of pain without motor symptoms.

Diagnosis.—Tetanus may be confounded with strychnin-poisoning, with hysteria, with tetany, or with hydrophobia. Wood's table makes the diagnosis clear between tetanus, strychnin-poisoning, and hysteria.\*

TETANUS.	Hysterical Tetanus.	STRYCHNIN-POISONING.
	Commences with blind- ness and weakness.	Begins with exhilaration and rest- lessness, the special senses being usually much sharpened. Dimness of vision may in some cases be manifested later, after the develop- ment of other symptoms, but even then it is rare.
Muscular symptoms usually commence with pain and stiffness in the back of the neck, sometimes with slight muscular twitching; comes on gradually. Jaw one of the earliest parts affected; rigidly and persistently set.	Muscular symptoms commence with rigidity of the neck, which creeps over the body, affecting the extremities last. Jaws rigidly set before a convulsion, and remain so between the paroxysms.	Muscular symptoms develop very rapidly, commencing in the extremities, or the convulsion when the dose is large seizes the whole body simultaneously. Jaw the last part of the body to be affected; its muscles relax first, and even when, during a severe convulsion, it is set, it drops as soon as the latter ceases.
Persistent muscular rigidity very generally, with a greater or less degree of permanent opisthotonos, emprosthotonos, pleurosthotonos, or orthotonos.	Persistent opisthotonos and intense rigidity be- tween the convulsions and after the convulsions have ceased, the opisthotonos and intense rigidity last- ing for hours.	Muscular relaxation (rarely a slight rigidity) between the convul- sions, the patient being exhausted and sweating. If recovery occurs, the convulsions gradually cease, leaving merely muscular soreness, and sometimes stiffness like that
Consciousness pre- served until near death, as in strychnin-poison- ing.	Consciousness lost as the second convulsion comes on, and lost with every other convulsion, the disturbance of conscious- ness and motility being simultaneous.	felt after violent exercise.  Consciousness always preserved during convulsions, except when the latter become so intense that death is imminent from suffocation, in which case sometimes the patient becomes insensible from asphyxia, which comes on during the latter part of a convulsion and is almost a certain precursor of death.
Draughts, loud noises, etc., produce convul- sions, as in strychnin- poisoning; may com- plain bitterly of pain.	Crying spells alternating with convulsions.	The "slightest breath of air" produces convulsion. Patient may scream with pain or may express great apprehension, but "crying spells" would appear to be impossible.
Eyes open and rigidly fixed during the convul- sion.	Eyes closed.	Eyes stretched wide open.
	Partial spasm in the leg, producing in Wood's cases crossing of the feet and inversion of the toes. If all the muscles were involved, eversion would occur, as the muscles of eversion are the stronger.	Legs stiffly extended with feet everted, as the spasms affect all the muscles of the leg.

Tetany is distinguished from tetanus by the milder nature of the spasms, by the greater limitation of the rigidity, by the fact that spasms begin in the hands or feet, not in the jaw and neck, and in most cases by periods of distinct intermittence.

<sup>\* &</sup>quot;Nervous Diseases," by Prof. H. C. Wood.

In hydrophobia tonic spasm does not exist, and if clonic spasms occur

they are secondary to suffocative attacks.

Treatment.—Far better even than to treat tetanus well is to prevent it. Careful antisepsis will banish it as a sequence of surgical operations as thoroughly as it has banished septicemia. Every infected wound must be disinfected with the most scrupulous care. Every punctured wound is to be incised to its depths and thoroughly cleaned and drained. In a very suspicious wound, such as a Fourth of July injury or a wound from a dung fork, or the entrance into the tissues of a splinter from a stable floor, after the removal of foreign bodies and thorough antiseptic cleansing, dust the wound with antitoxin powder or, better, give 2000 or 3000 units of antitetanus serum hypodermatically. It seems reasonably certain that tetanus antitoxin has prophylactic power, in fact, Jacobson and Pease say that "as a prophylactive measure it merits our fullest confidence" ("Annals of Surgery," Sept., 1906). Obviously, this cannot be done for every wound. The procedure is not a certain preventative. Reynier injected antitoxin into a patient on whom he was about to operate because there was a case of tetanus in the wards, and yet this man developed tetanus ("Gaz. des Hôpitaux," July 16, 1901). Thirty light cases have been reported in which prophylactic injections failed to prevent the disease. When in spite of such injections the disease does arise, it is apt to be mitigated in violence. Nevertheless it is sure that animals can be rendered immune to tetanus, and the prophylactic power of antitoxin is warmly advocated by many eminent men. It is extensively and most successfully used by veterinarians to prevent tetanus after castration of horses, and this success is a guide-post to us. The following table is most suggestive (quoted by Heineck in "Surgery, Gynecology, and Obstetrics," Jan., 1909, from Scherck's article in "Jour. Am. Med. Assoc.," 1906, vol. xlvii, p. 500). It sets forth the Fourth of July injuries treated in St. Louis dispensaries:

Years.	No. of cases.	Antitetanic serum as a preventative.	Death from tetanus.
1903	56	no	16
1904	37	yes	none
1905	84	yes	none
1006	170	ves	none

Puerperal tetanus is prevented by antiseptic midwifery, and tetanus neonatorum is obviated by the antiseptic treatment of the stump of the cord.
In order to obviate all danger of the development of tetanus during vaccinia,
perform the little operation with cleanliness and care properly for the wound
and for the pustule. The skin should be cleansed with soap and water, rubbed
with alcohol, and washed with boiled water. It should be gently scraped with
a knife (which has been boiled) until serum exudes. The virus, taken from
a hemetically sealed tube, is applied to the raw surface and allowed to remain
exposed to the air until dry. A piece of sterile gauze is laid over the part and
is beld in place by a bandage. This dressing is changed once or twice a
day, as may be necessary, and is used until granulation begins, at which time
the use of any simple ointment is admissible. Do not apply a shield. The
rail of shields is pointed out by Robert N. Willson ("American Medicine,"
Dec. 7, 1901).

When tetanus exists, always look for a wound, and if one is found, open

it; if there are sloughs, cut them away, wash the wound with peroxid of hydrogen and then with hot normal salt solution, dry the wound with gauze, paint the surfaces of the wound with bromin, and secure drainage by packing with iodoform gauze. Dennis disinfects the wound with a solution of tri-chlorid of iodin (0.5 per cent.).

Surgeons of a former day were accustomed to amputate for tetanus if the wound was upon an extremity. When we reflect that the poison-producers are in the wound and not in the circulation, it seems a reasonable treatment. As a matter of fact, it never does any good, because, when the symptoms begin, the toxin has already entered into the nerve-cells and become fixed. Kitasato has shown that if a mouse is inoculated with tetanus near the root of the tail, excision of the tail and cauterization of the stump will not prevent tetanus unless it is performed within one hour of the inoculation; and Nocard inoculated sheep near the root of the tail with tetanus spores, and although the moment symptoms appeared he amputated well above the point of inoculation, the animals died of the disease. We must regard amputation as a useless method of treatment.

Keep the sufferer from tetanus in a darkened, well-ventilated, and quiet ar artment, so as to exclude as far as possible peripheral irritation. Watch for the occurrence of retention of urine, and use the catheter if necessary. Secure movements of the bowels by administering salines, castor oil, croton oil, or enemas. Stimulate freely with alcohol. Give plenty of concentrated liquid food unless swallowing causes convulsions, then feed by the rectum, and give fluids by hypodermoclysis. If swallowing causes convulsions some surgeons give an inhalation of nitrite of amyl before an attempt is made to swallow. If this treatment does not make swallowing possible then partially anesthetize the patient and feed him by means of a pharyngeal tube passed through the nose. Better than either of these plans is to abandon mouth feeding. Large doses of the bromid of potassium, or of this drug with chloral, give the best results, as far as drug treatment is capable of giving results. If bromid is used, give about 3j every four to six hours. Other drugs that have been used with some success are gelsemium, morphin, curare, injections and fomentations of tobacco, physostigmin, anesthetics, cocain, and cannabis indica. An ice-bag to the spine somewhat relieves the girdle pain. Hot baths have been advised. It is said that venesection followed by the intravenous infusion of saline fluid does good. This procedure is followed by a free flow of urine and by lessening of the number of the paroxysms. It may be repeated several times during a few days (E. J. McOscar, in "American Medicine," Sept. 14, 1901; A. V. Moschcowitz, in "Med. News," Oct. 13, 1900).

Yandell says, in summing up Cowling's report on tetanus:\* "Recoveries from traumatic tetanus have been usually in cases in which the disease occurs subsequent to nine days after the injury. When the symptoms last fourteen days, recovery is the rule, apparently independent of treatment. The true test of a remedy is its influence on the history of the disease. Does it cure cases in which the disease has set in previous to the ninth day? Does it fail in cases whose duration exceeds fourteen days? No agent tried by these tests has yet established its claim as a true remedy for tetanus." †

<sup>\* &</sup>quot;American Practitioner," Sept., 1870.

<sup>†</sup> Quoted by Hammond, in his "Diseases of the Nervous System."

It is now claimed by some observers that we have a remedy which fulfils the requirements of Yandell in the tetanus antitoxin serum. Behring's serum is said to be six times as strong as Tizzoni's, but it is difficult or impossible to estimate the exact power of either. Behring and Kitasato succeeded in immunizing animals and Tizzoni and Cattani discovered that the antitoxin is an enzyme. The antitoxin destroys the activity of the toxin and is obtained from an immunized horse.

If injected subcutaneously it is absorbed very slowly and even twentyfour hours or more after such an injection a considerable amount remains unabsorbed in the tissues. It is not absorbed at all by the nervous structures. It is eliminated rapidly and unaltered in the urine, feces, and sweat. It seems to be harmless and its immunizing powers are certain. Its curative power is very much less certain. Hypodermatic injections are practically useless. Intravenous injections are of more service, but even then the antitoxin only grasps the toxin in the blood and fails to reach that in the nerves, nerve-cells, and nerve tracts. Some practise intramuscular injections, but 7 acute cases so treated died, a mortality of 100 per cent. (Jacobson and Pease, "Annals of Surgery," Sept., 1906). Injection into the theca of the cord (intraspinal injection) by means of lumbar puncture is an attractive method but the inability of nerve-elements to absorb antitoxins when the pia intervenes, is an argument against it, though in one violent acute case of my own, occurring in a boy, recovery followed this method. In 7 acute cases treated by this method the mortality was 57.1 per cent. (Jacobson and Pease, in "Annals of Surgery," Sept., 1906). John Rodgers injected antitoxin into the cauda equina and nerves and cured two apparently hopeless cases ("Med. Record," July 2, 1904). Injection into a nerve (intraneural injection) is a more rational method, but even this plan is only of service in localized tetanus, the main nerve above the part tetanized being injected (Küster, in German Surgical Congress of 1905). However antitoxin is given the dose must be large if any good is to be done. Serum is usually prepared as follows: A horse is injected repeatedly with the toxins obtained from cultures of tetanus bacilli, the strength of the injections being gradually increased. Eventually the animal becomes immune to tetanus. Some days after the final injection a cannula is placed in the jugular vein of the immunized animal, blood is drawn into a sterile vessel and is permitted to coagulate during twenty-four hours, and at the end of this period the serum is separated from the clot, is evaporated to dryness in a vacuum over sulphuric acid, and the powder is placed in hermetically sealed glass tubes. In order to use the serum, dissolve the powder in sterile water, in the proportion of 1 gm. to 10 c.c. The fluid serum sold in the shops bears this proportion to the powder. The serum can be given subcutaneously or intravenously, or can be injected into the brain or under the cerebral dura or the spinal arachnoid, or into a nerve. If used subcutaneously, from 20 to 30 c.c. of the fluid serum should be injected into the abdominal wall, and this dose should be given every six or eight hours until there is improvement. Then from 5 to 10 c.c. should be given every six or eight hours. As the symptoms abate the dose is lessened and the intervals between the doses are increased. In a violent case of tetanus the first dose should consist of 40 to 50 c.c., and this can be repeated in four or five hours. In a case of tetanus which recovered, reported by Mixter, enormous doses were given. This patient received in the aggregate 3400 c.c. of serum, or 285 c.c. a day.\* In 47 acute cases treated by subcutaneous injection the mortality was 82.6 per cent. In 30 acute cases treated by a combination of either subcutaneous, intraspinal, intravenous, or intracranial injections the mortality was 93.1 per cent. (Jacobson and Pease, in "Annals of Surgery," Sept., 1906). Roux and Borrel maintain that the toxins of tetanus pass from the blood into nervous tissue and are fixed in the nerve-cells. As the antitoxin when given hypodermatically or intravenously remains in the blood, it can only antidote the poison in the blood and not that in the nerve-cells. These observers advise that the antitoxin be placed where the toxins are active-that is, that it be thrown into the cerebrum (intracerebral injections). The skull is trephined or opened with a small drill, a blunt needle is passed to the depth of one and a half inches into the frontal lobe, and the serum is slowly injected. Abbe follows Kocher; uses a local anesthetic and bores a very small hole through the skull midway between the outer angle of the orbit and the middle of a line running across the head from one external auditory meatus to the other. The serum should be concentrated. One gram of dry antitoxin is dissolved in 5 c.c. of water, and this amount is the proper dose. The opposite frontal lobe should also be injected either at once or the next day. Even when serum has been injected into the cerebrum it should also be given subcutaneously. Abbe employed intracerebral injection in 5 severe cases and 3 of them recovered. He is a strong believer in the method ("Annals of Surgery," March, 1900). Moschcowitz has collected 38 cases so treated and claims that one-half of them recovered. Cerebral abscess followed in r case ("Med. News," Oct. 13, 1900). Tuffier has reported a successful case in which he injected 10 c.c. of serum into each frontal lobe ("Gaz. heb. de Med. et Chir.," July 4, 1901). The method has of late been practically abandoned in spite of the early favorable reports.

The value of the tetanus antitoxin in acute tetanus is more than doubtful. Under its use the mortality from acute tetanus is said to fall from nearly 90 per cent. to 75 per cent., but the figures above given do not sustain this contention. Neither do the figures indicate that the mortality in chronic tetanus

has been greatly influenced by it.

Kitasato has shown that injections of iodoform render animals immune, and Sonnani has maintained that this drug placed in a wound prevents the disease. If antitoxin is not obtainable, give hypodermatic injections of iodoform, 3 to 5 gr. t. i. d.

Bacelli's treatment consists in the hypodermatic injection of carbolic acid, which is thought to grasp tetanus toxin and mitigate its virulence or even make it inert. The dose is 15M of a 3 per cent. solution every two hours.

Favorable results are claimed for the plan.

The hypodermatic injection of an emulsion of fresh brain-matter has been advocated on the ground that brain-matter and tetanus toxin have a mutual affinity (Krokiewicz). The results are not conclusive.

Mathews reports cure in 2 cases following the very gradual introduction into a vein of a solution containing sodium chlorid, sodium citrate, sodium sulphate, and chlorid of calcium ("Jour. Am. Med. Assoc.," August 29, 1903). Cure of acute tetanus has followed the intraspinal injection of a solution of magnesium sulphate (see page 103), which drug, Meltzer has shown, strongly

<sup>\*&</sup>quot;Boston Med. and Surg. Jour.," Oct. 6, 1898.

stimulates inhibition. Blake has reported such a case ("Jour. of Surgery, Gynecology, and Obstetrics," May, 1906). If magnesium sulphate is used, 5 cc. of a 25 per cent. solution are injected into the subarachnoid space of the cord. After such an injection there is marked muscular relaxation lasting a number of hours. When the improvement ceases another dose is given. Heineck ("Jour. of Surgery, Gynecology, and Obstetrics," Jan., 1909) reports a successful case and collects 12 other cases so treated, 7 of which died.

Murphy reports the cure of a case by spinal puncture and injection of morphin and eucain into the theca of the cord ("Jour. Am. Med. Assoc.," August 13, 1904).

## XIII. SURGICAL TUBERCULOSIS.

Tuberculosis is an infective disease due to the deposition and multiplication of tubercle bacilli in the tissues of the body. The term surgical tuberculosis is applied to all of those numerous tuberculous lesions that demand surgical treatment. Such lesions may exist in different structures, often seem clinically to be strictly localized processes, and in many instances may be extirpated, drained, or sterilized. Among the conditions placed under the beading of surgical tuberculosis are: Tuberculosis of glands, of bones, of joints, and of the skin. These lesions are most common in children, the majority of cases are curable, and they are not so often associated with or

followed by pulmonary phthisis as are some other tuberculous lesions. They tend in many cases to remain local and, beyond doubt, a considerable number of them are due to infection with bovine bacilli. Tuberculosis is characterized either by the formation of tubercles or by widespread cellular proliferation (diffuse tubercle) or by fibrinous exudation, which is very rich in cells. Tuberculous conditions tend to caseation, sclerosis, or ulceration.

A tubercle is a non-vascular infective focus, appearing to the unaided vision as a semi-transparent gray or yellowish mass the size of a mustard-seed. The microscopic tubercle is the most characteristic evidence of the disease. The microscope shows that a gray tubercle consists of a number of cell-clusters, each cluster constituting



Fig. 97.—Synovial membrane, showing giant-cells (Bowlby).

a primitive tubercle. A typical primitive tubercle shows a center consisting of one or of several polynucleated giant-cells surrounded by a zone of epitudioid cells which are surrounded by an area of lymphocytes. When the tacillus obtains a lodgment the fixed connective-tissue cells multiply by laryokinesis, forming a mass of nucleated polygonal or round cells. These cells are connective-tissue cells and derived particularly from endothelium and are called epithelioid cells from their resemblance to epithelial cells. Early in the development of a tubercle blood channels lined with epithelioid cells exist, but continued cell proliferation blocks the channels and at the same time the blood-supply of the growth is further limited by the pressure

of proliferating perivascular cells and the proliferation of the endothelial cells of adjacent vessels. Some of the epithelioid cells proliferate, and others attempt to, but fail for want of blood-supply. Those which fail to multiply succeed only in dividing their nuclei and enormously increasing their bulk (giant-cells). Giant-cells, which may also form by a coalescence of epithelioid cells, are not always present. Giant-cells are not certain evidence of tuberculosis, for they occur in syphilitic lesions. The presence of irritant bacterial products induces surrounding inflammation and numbers of leuko-

cytes gather about the epithelioid cells (Fig. 97).

The bacilli, when found, exist in and about the epithelioid cells, and sometimes in the giant-cells. When bacilli enter the tissues they are often killed. If they enter in large numbers or are peculiarly virulent they induce chronic inflammation, granulation tissue forms, and the cells of the focus often have the characteristic arrangement described above. The bacilli are not pyogenic and suppuration means secondary infection. A tuberculous focus tends strongly to degenerative changes because of the local anemia and the presence of bacilli. If numerous active bacilli are present caseation takes place. This is coagulation necrosis due to the action of bacteria upon a non-vascular area. It starts at the center of a tuberculous focus and spreads toward the periphery and finally forms masses like cheese. When caseated material is mixed with serum tuberculous pus is formed.

A caseated focus may be surrounded or encapsuled by fibrous tissue. When this happens the tuberculous process may remain latent for months or years, perhaps awakening into activity as the result of a traumatism or lowered general resistance. A caseated focus may be cured by growth of fibrous tissue which replaces the tuberculous focus. This is cure by sclerosis. A caseated area may calcify. Even when tuberculous pus forms encapsulation may occur, the fluid being absorbed, and the remains being surrounded by fibrous tissue. Whenever tubercle bacilli consume all available food they die or remain latent. If they die the granulations are converted into fibrous tissue and the part is healed. If they remain latent they may at any time become again active. Infiltrated tubercle is due to the running together of many minute infective foci, or to widespread infiltration without any formation of foci. Infiltrated tubercle tends strongly to caseate. The description of a tubercle previously given relates to the common reticulated tubercle. varieties exist.

The fibrous tubercle is much richer in dense connective tissue than is the ordinary tubercle. It forms when bacilli are greatly weakened or killed. When this happens embryonal cells cease to degenerate, and ordinary inflammation results in fibrous tissue formation. Fibrous tubercle is evidence of an effort at cure.

Hyaline tubercle results from hyaline degeneration of the reticulum of an

ordinary tubercle and is the early stage of coagulation necrosis.

The Incidence of Tuberculosis.-Tuberculosis is the most widespread of diseases, being particularly common in northern countries, in civilized regions, and in great cities. Both men and domestic animals suffer from it, and it is occasionally met with in captive wild animals. It may even occur in cold-blooded animals. It is rare in savage races and extremely rare in wild animals dwelling under natural conditions.

How many persons die of tuberculosis is a much debated point. Some writers claim that consumption of the lungs alone kills one-third of all that die; and if the deaths from various other tuberculous lesions are added to this, it will be seen what an enormous part the disease plays in the mortality tables. Many observers hold that one-third of the human race suffer with tuberculosis, and that in every country the remaining two-thirds free from the disease are every moment in danger of acquiring it. Evans has maintained that of the 35,000,000 deaths that occur yearly in the world, 5,000,000 are the result of tuberculosis. Pflügge thinks that one-seventh of the race dies of tuberculosis. Sherman G. Bonney, in his work on Pulmonary Tuberculosis, asserts that "from 85 to 95 per cent. of the human race have been at some period of life the subject of tuberculous infection" and that 1 person in 7 dies of the disease.

This enormous incidence of the disease, however, is disputed by some authorities; notably, by G. Cornet (Nothnagel's "Encyclopedia of Practical Medicine"). This distinguished observer states that one-seventh of all deaths result from tuberculosis, and that some pathologists have reported that in one-third of all necropsies tuberculous lesions are found; but that these statistics are obtained from institutions where only the very poor are cared for, and that the percentage of tuberculosis is vastly lower in the better classes of the community. The exact figures, however, are hard to determine. It is certain that enormous numbers of people are affected with tuberculosis. I believe many affected ones recover, for Naegeli points out that almost all who perish after thirty from non-tuberculous conditions show healed lesions of tubercle. Von Behring maintains that all of us are "a little tuberculous" Jonathan Wright, in "New York Med. Jour.," April 2, 1904). Pflügge maintains that from 50 to 70 per cent. of the human race are predisposed tuberculous infection, and if infected would die of it unless an intercurrent malady destroyed them.

The Bacillus of Tuberculosis.—The tubercle bacillus was discovered by Robert Koch in 1882. It is a little rod with a length about equal to one-half the diameter of a red corpuscle. It is non-motile, does not form spores, and requires oxygen in order to grow, but it may obtain oxygen from body-cells or fluids. Tubercle bacilli exist in all active tuberculous lesions, and the more active the process the greater their numbers. They may not be found in a tuberculous area, having once existed, but died out for want of nourishment. For instance, in a cold abscess they are frequently absent. Bacilli may be destroyed by a secondary infection, for example, by a pyogenic infection. Even when present, tubercle bacilli may be overlooked. Differential staining may exhibit the bacilli. In the material from an active tuberculous lesion, even if bacilli are not found, injection of the tuberculous matter into a guinea-pig will be followed by the production of the disease, and in these lesions bacilli can be demonstrated. Bacilli may be widely distributed throughout the body. It has long been taught that they may occasionally though seldom be demonstrated in the blood in cases of acute miliary tuberculosis. Rosenberger ("American Jour. of the Med. Sciences," Feb., 1909) seems to prove that bacilli are invariably present in the blood in all cases of tuberculosis. We have failed to find them in the past because of defective methods employed in the search. He finds them in cases of acute miliary tuberculosis, cases of advanced tuberculosis with cavity formation, and cases of incipient tuberculosis. In other words, if Rosenberger is correct, and I believe he is, tuberculosis in all its forms is a bacteremia. The method employed by Rosenberger will be found in the article previously referred to. This method promises to be of enormous importance in diagnosticating incipient tuberculosis. We have discussed the tubercle bacillus on page 51. The bacillus of leprosy, the smegma bacillus, and the tubercle bacillus are similar, but not identical. Each is an acid-fast bacillus; that is, if stained with an anilin color, mineral acids will not wash out the stain. All acid-fast bacilli are capable of producing lesions that, to some extent at least, resemble tuberculous lesions; but the lesions produced by all, except the tubercle bacillus and the leprosy bacillus, tend to cure. It is possible that all acid-fast bacilli are branches from a common stem.

The tubercle bacilli obtained from different animals differ considerably, both in morphology and in virulence. Koch asserted, in 1001, that the bacilli of human tuberculosis differ radically from those of bovine tuberculosis, that human tuberculosis cannot be given to cattle at all, and that it is so difficult to transfer bovine tuberculosis to the human being that the danger from infected cattle is utterly trivial and may be disregarded. Ravenal and others have positively opposed this view of Koch's and there have been reported what appear to be undoubted cases of the transference of tuberculosis from animals to man. There is still dispute upon this point, but most writers believe that bovine tuberculosis and human tuberculosis are essentially the same, although the bacilli present temporary differences due to altered environment. The bacilli of bovine tuberculosis are certainly far less dangerous to man than are the bacilli of human tuberculosis, and the bacilli of human tuberculosis are vastly less dangerous to cattle than are the bacilli of bovine tuberculosis. The bacilli of bovine tuberculosis, when they find lodgment in human tissues, are apt to produce local lesions and seldom disseminate, and vice versa. It has been proved that many cases of tuberculous cervical adenitis are due to bovine bacilli. In some cases cattle have been successfully infected with human bacilli. Human infection with bovine bacilli is most common in the young, and such infections tend to spontaneous cure. The histologic lesions seen in man and cattle are identical and so are the degenerative changes, and, as Baumgarten showed, cattle react to tuberculin obtained from human bacilli.

Nocard reports 2 cases of individuals who wounded themselves while cutting the flesh of tuberculous cattle. Both developed generalized lesions and died. Ravenel strongly opposes the view of Koch and maintains that the bacillus of bovine tuberculosis is highly pathogenic for man ("University of Penn. Med. Bull.," xiv, 238, 1901). The same author has reported 4 cases of undoubted inoculation tuberculosis in the hands of veterinarians. Similar cases have been placed on record by other observers. The entire question is one of immense importance. If Koch is right, there is practically no danger to man in eating tuberculous meat or in drinking tuberculous milk. Most observers endorse the words of the report of the British Commission of 1904. This commission positively maintained that bovine tuberculosis can be communicated to man.

Distribution of the Bacilli.—These bacilli are parasites, and not saprophytes; and the real source of infection is a tuberculous person or animal. Wherever there are tuberculous men or animals the bacilli get into the air. The number that get into the air depends upon the number of animals affected, the seat of the tuberculous lesion in each, the care taken by the

victims, and the control exercised by the community.

Tubercle bacilli from an infected individual may get into the atmosphere from the urine, the sputum, the feces, the sweat, the milk, or caseous or purulent material. The bacilli from dried sputum enter the dust, in which, fortunately, they are usually destroyed quickly by the complete dryness, the oxygen of the air, and the sunlight; but under some circumstances they may retain their virulence for weeks or even for months. The infected area itself is usually the direct source of the bacteria from a given case of tuberculosis, but this is not invariably so; for a tuberculous woman with a healthy mammary gland may secrete milk containing tubercle bacilli, a consumptive free from genito-urinary tuberculosis may occasionally pass urine containing bacteria, a cow may give tuberculous milk when the udder is not diseased, and tubercle bacilli may enter the bile of a tuberculous patient. The Third Interim Report of the Royal Commission on Tuberculosis states positively that the milk of tuberculous cows may contain bacilli even when the udder is not diseased. It is probable that flies and insects may transmit infection (Lord, in "Boston Med. and Surg. Jour.," 1904, cli); and it is certain that putrefaction does not surely destroy tubercle bacilli. This is proved by the fact that living bacilli may be passed in the feces of an animal that has been fed on tuberculous meat, and that they may be found in the feces of an individual suffering with intestinal tuberculosis. We are thus justified in concluding that slaughterhouse waste, if improperly disposed of, is a danger to the community.

Routes of Infection. - An individual may acquire tuberculosis by inhaling tuberculous material (inhalation tuberculosis), by swallowing tuberculous material (ingestion tuberculosis), and by inoculation with tuberculous material (inoculation tuberculosis). Infection of the lungs is commonly brought about by the inhalation of dried tuberculous sputum or dust carrying tubercle bacilli. Ingestion tuberculosis may follow the eating of tuberculous meat, the drinking of tuberculous milk, or the consumption of uncooked articles on which tubercle bacilli have gathered. It has been shown that the lacteals may take up tubercle bacilli from the intestine, even if there is no intestinal lesion; and that bacilli can pass through the thoracic duct and into the blood, and lodge in some tissue, particularly the pulmonary tissue, so inducing tuberculosis. They tend to lodge at any point of least resistance; and if not caught up in the lungs, will tend to be arrested in some other region that has been the seat of a trifling injury-for instance, in an epiphysis that has been strained. It is a peculiar fact that a trivial injury constitutes a point of least resistance; but a severe in-Jury, such as a fracture of a bone, does not do so. Baumgarten was a strong believer in the idea that bacilli enter the organism with the food and von Behring now warmly advocates the same view, teaching that bacilli enter the organism of every person in early life. They may be destroyed by tissue restance, but if not destroyed have a period of latency and, finally, perhaps after years, become active and cause the disease ("Deutsche Med. Woch.," Sept 24, 1903).

It is certain that inoculation may be followed by tuberculosis. The inoculation of tubercle bacilli in the intestine may produce intestinal ulceration. It

has been shown experimentally that rubbing the bacilli into the nasal mucous membrane may produce a local area of disease. Inoculation of the skin may result from a wound, the bacilli being carried into the wound itself. The victims of cutaneous inoculation are usually butchers, physicians who have made post-mortem examinations, and workmen who handle hides. In these cases, as a rule, an ulcer promptly forms at the point of inoculation; but in some few cases the wound heals soundly and tuberculous lesions develop in its neighborhood. In still rarer instances no apparent inflammation or ulceration occurs in or around the seat of inoculation; but the anatomically related lymph-glands become tuberculous.

A number of cases of inoculation tuberculosis have been reported. I have treated one, a physician, who inoculated his finger while making culture studies with tuberculous material. In this case the axillary glands became tuberculous. I have also seen a tuberculous ulcer of the forearm in an attendant of a lunatic asylum, who had been bitten by a tuberculous patient. Inoculation tuberculosis occasionally follows circumcision, as practised by an orthodox rabbi, the operator having been tuberculous. There have been reported apparent cases of direct inoculation of the genito-urinary tract during sexual intercourse. If there has been some definite injury of the tissues, inoculation may follow a simple rubbing of tubercle bacilli into a part.

When the mother's ovum is tuberculous, the disease may be directly transmitted to the fetus, producing the condition known as congenital tuberculosis. Rosenberger found bacilli in the blood from the umbilical cord of the placenta of a tuberculous mother. This proves that congenital tuberculosis may exist even when the ovum is not known to be tuberculous, and also that a child born by a tuberculous mother is, if not immune to the bacteria, tuberculous from the moment circulation is established between embryo and mother. Baumgarten believes that bacilli may pass the placenta, enter the fetus, and remain latent for years. Latent bacilli have been found in normal lymphnodes (Harbitz, in "Jour. Infect. Diseases," vol. ii, 1904); this proves that latency is possible. However common the direct transmission of bacilli may be, the direct transmission of the disease is unusual, but the transmission of an hereditary predisposition to infection is not unusual. In spite of recent assertions to the contrary, I believe that there is such a thing as hereditary predisposition to tuberculosis. The experience of the human race uniformly confirms the belief in predisposition. In some cases of tuberculosis we can satisfy ourselves clinically as to the cause of the infection. For instance, when an individual is injured with an object known to carry tubercle bacilli, if an ulcer of the skin forms, and the adjacent lymphatic glands enlarge, the deduction is In other cases, it is impossible to make up our minds as to the cause of a tuberculous lesion. For instance, we can only guess that a person has inhaled tuberculous material or has eaten tuberculous food. If in inoculation tuberculosis no lesion arises at the point of entry, the opinion as to the causation will be founded merely upon guess-work.

It seems sure that when the bacilli of tuberculosis enter into the body, if they are not destroyed by the body-resistance, they either produce a local lesion at the site of inoculation, or pass to the nearest lymphatic glands or to some point of least resistance, and there establish disease. The first lesion is known as the primary focus, and from this focus the disease may be disseminated to the most distant parts. The bacilli enter readily if there is a wound or an abrasion; but in exceptional circumstances they may enter through unbroken skin and undamaged mucous membrane. Any structure may become tuberculous, but some structures are much more liable to do so than others.

The lungs are very liable; the conjunctiva is very resistant.

We have previously quoted Rosenberger's view that tuberculosis is a bacteremia in all cases. The bacilli which enter the blood may pass out in the unine or feces, may produce local lesions, or may induce advancing and widespread tuberculosis. Dissemination by the lymph-stream is known clinically to occur, and it means slowly advancing tuberculosis with localization of lesions. In dissemination by the lymph-stream, the dissemination is usually in the normal direction of the lymph-current; but if the lymph-vessels become blocked, lymph-regurgitation may occur, and then the dissemination takes place in a direction opposite to the normal flow of the lymph-current.

Products of the Tubercle Bacilli .- A great variety of products are formed by the tubercle bacilli, and among them we may mention alkaloids, toxalbumins, fatty acids, and ferments. Experimental injection of the toxalbumins produces inflammation; and of the alkaloids, fever. It has been shown by Maragliano that injection of the toxalbumins actually lowers the temperature. Beyond any doubt, the culture-material in which tubercle bacilli are growing contains poison; and the bodies of the bacilli themselves contain poison. The poisons in the culture-medium are called extracellular poisons, and those within the bacilli are called intracellular poisons. It is quite probable that the former poisons are identical with the latter, and have merely passed from the bacilli into the culture-medium.

Tuberculin.—It was proved some time ago that dead bacilli are toxic and, if experimentally injected, induce a toxic condition in the animal, cause inflammation of the kidneys, and sometimes produce cold abscess subsequently at the seat of injection. In 1800 Koch collected the poison from dead bacteria in the form of a liquid, which he called tuberculin. A number of different methods of extracting such poison have been suggested; hence, there are a number of different tuberculins. Koch has made several himself. His early tuberculin was made by making a glycerin-bouillon culture of tubercle bacilli, traporating on a water-bath to one-tenth of its volume, and filtering out the dead bacilli. The filtrate contained tuberculin mixed with glycerin. Later Koch prepared tuberculin from virulent cultures of bacilli, dried, ground up, and mixed with water, the fluid being centrifuged for forty-five minutes. When centrifuged, two layers separate. The upper layer, which is white and opalescent, contains the elements soluble in glycerin, is like the old tuberculin, and is called TO. The lower layer contains an emulsion of insoluble elements of high immunizing power, and is called TR. In 1901 Koch presented another tuberculin (BE) of dried bacilli in equal amounts of glycerin and water.

It was discovered by Koch that tuberculous animals are much more strongly affected by an injection of tuberculin than are healthy animals. The most positive reaction is noted in the tuberculous area; but, as a rule, there is also a reaction in the area where the injection is made. We get no reaction from the administration of tuberculin by the stomach, but occasionally can obtain it by the inhalation of the dried material. If a moderate dose of tuberculin is injected into a non-tuberculous animal, there may be a trivial redness at the point of injection and a slight and temporary rise of temperature; or there may be no evidence of reaction whatever. An injection in a tuberculous animal, however, is followed by distinct inflammation at the seat of injection, and a positive reaction in the tuberculous area. This area undergoes congestion or inflammation, leukocytes collect around it, and the part tends to necrosis and is liable to break down.

In addition to the changes already mentioned, there is elevation of temperature. If the dose has been small, there may be only a slight feeling of coldness to usher in the rise of temperature; but if the dose has been large, there is usually a distinct chill. This chill comes on eight to twelve hours after the injection and is accompanied and followed by elevated temperature. The fever lasts from four to twenty-four hours, and the temperature may be elevated to from two to five degrees Fahrenheit. The febrile condition is accompanied with pain in the head, limbs, and back, and with increased rapidity of the circulation, restlessness, weakness, and usually nausea. As the temperature passes to normal all the symptoms disappear. The slight elevation of temperature which may be noted after tuberculin has been injected into a non-tuberculous animal is not ushered in by a chill, and does not exceed one degree Fahrenheit, unless a very large dose has been given. We thus note that the injection of tuberculin may be of the greatest possible value in diagnosis.

A good many observers have grown fearful of injecting tuberculin, believing that it is liable to cause the tuberculous focus to spread, or actually to lead to the development of disseminated tuberculosis. Virchow was of this opinion. That such a condition may follow the use of large doses seems certain, but moderate or small doses appear to be entirely safe. Flick has pointed out that if a blister is applied to a tuberculous person a distinct febrile reaction appears a number of hours after the application. This is due to the absorption of toxic material, probably tuberculin, from the blister. It is known that in a tuberculous animal certain excretions (urine) and serous exudates contain tuberculin. Mérieux and Baillon show that if a tuberculous person is blistered the fluid of the blister, injected into a tuberculous animal, produces a definite reaction. This proceeding is of diagnostic value. The tuberculin comes from the tuberculous person and he is proved to be tuberculous by injecting the tuberculin into another tuberculous animal.

Professor Behring (Paris Congress of Tuberculosis, Oct., 1905) maintains that there is a curative principle not identical with antitoxin. He obtains a substance from tuberculous material, which he calls T. C. and he introduces this substance into the living body. When T. C. is acted on by the cells of the living body, it is altered; and the hypothetical material, T. X., is formed. This distinguished laboratory worker says that the T. C. is the vital principle; and that when cattle are immunized by inoculating attenuated bacilli, the T. C., by acting on the body-cells, is responsible for the diagnostic reaction to tuberculin and for the protective action towards tuberculosis. Some try by means of supposed antitoxins to immunize the body-fluids, but he tries instead to immunize the body-cells. He is unwilling to inject living tubercle bacilli into human beings; so he frees the tubercle bacilli of certain substances, leaving an organism that resembles the tubercle bacillus, which he calls the rest bacillus. This rest bacillus is, by certain methods, converted into an amorphous material identical with the T. C. formed by the action of

the body-cells upon the virus. This T. C. is taken up by lymph-cells; and it so changes these cells that they are converted into eosinophiles or oxyphiles, and the change in these cells makes the body immune. T. C. may safely be injected, as it is not a living material; and, whereas it may produce tubercles, they do not tend to caseate. Professor Behring believes that this material may be used in the treatment of human tuberculosis.

Resistance of Bacilli.—Among the antagonistic elements, we have mentioned oxygen, dryness, and sunlight. Moist heat, at the temperature of boiling water, is rapidly fatal. A 5 per cent. solution of carbolic acid is one of the most powerful of germicides. Full-strength alcohol is next in point of power. Corrosive sublimate is not a satisfactory germicide. Formaldehyde is fatal only after long exposure. Iodoform and ether is a reasonably powerful mixture.

That the virulence of tubercle bacilli varies under different circumstances is sure. Under some circumstances they may be extremely powerful; under others nearly innocuous. The liability to infection depends, perhaps, in part, on individual predisposition, and certainly, to a great extent, on the number and the virulence of the bacteria.

Immunity.—It seems likely that some persons are immune to tuberculosis. Such persons may come from an ancestral line in which all the predisposed have died off, so that the immediate ancestors of the line were nonsusceptible. The tendency to immunity may be strengthened by proper marriages, and may be weakened by improper marriages; or immunity in a line may be destroyed by the continuance of unfavorable conditions. It is sometimes noticed that during the progress of a localized tuberculous infection a deepseated tuberculosis (for instance, phthisis) improves. This exhibits a progressive development in the powers of the organism to resist infection by stimulation of the apparatus for opposing infection. That numbers of people get entirely well of tuberculosis is certain and that such people have secured prolonged immunity in many cases is probable. Paretic ailments seem to possess a high degree of immunity to tuberculosis (Rosanoff, in "Jour. Amer. Mod. Assoc.," February 13, 1909). Of course, the term immunity is only relathe. No one can be absolutely immune; for when subjected to extremely unfavorable circumstances, or when a number of virulent bacilli are introduced, anyone may become tuberculous.

Predisposition.—Personally, I believe that there is such a thing as a predisposition toward tuberculosis, just as there is toward many other diseases. Such a predisposed individual possesses temporarily or permanently a condition of the body-cells, body-fluids, or both, that either makes easy the entrance of the bacilli or prevents strong opposition to their multiplication when they have entered. A person is predisposed to an infectious disease when the opsonic index is low, for this indicates lack of phagocytic power in the leukocytes. Predisposition may be increased by some extraneous circumstance, such as occupation, residence, etc., that brings the individual into frequent or prolonged contact with virulent bacteria.

There is certainly such a thing as congenital tuberculosis, and any tissue may be involved in the congenital trouble. Rosenberger showed that blood in umbilical veins from the placenta of a tuberculous mother contained bacilli ("Amer. Jour. Med. Sciences," 1909). Young children are very liable to

tuberculosis of the acquired form. According to Professor Behring, many children become infected with tuberculosis in their early years by eating tuberculous food; but such a tuberculosis often remains latent for a considerable length of time, and then develops. This theory obtains probably from the fact that the digestive organs of the child are not strongly protective against bacteria as are those of the adult.

A question is, Do certain individuals possess a special predisposition to develop tuberculosis, and is this hereditary? Hereditary predisposition was once regarded as practically the only cause of the disease, but many thinkers now regard it as of slight importance, although I do not see how we can deny its existence. To do so is to run counter to the experience of the human race in all countries and at all times. We all see how common is tuberculosis in the descendants of tuberculous persons. Hutley studied 432 cases of tuberculosis. In 23.8 per cent, one or both parents had the disease (the father alone in 11.5 per cent., the mother alone in 9.9 per cent., and both in 2.4 per cent.). Some maintain that in 30 per cent. of consumptives, one parent or both parents have been consumptives, and in 60 per cent. a parent or a grandparent has suffered with tuberculosis. Because of the extreme frequency of the disease, however, this statement does not prove that the cases in the family are due to heredity; but that there must be such a thing as hereditary predisposition is indicated by the fact that there are many families living under similar conditions to the tuberculous families, without there having occurred, through several generations, a single case of tuberculosis among their members. A feature that makes us unable to reach a certain conclusion is that tuberculosis is contagious and several members of a family may be infected from one member, even when there is no predisposition to the trouble by heredity. The mere living in one house may account for the infection. A fact strongly in favor of the hereditary influence is that in a family whose ancestors have been tuberculous and whose members have not lived together, but have been scattered widely over the earth, member after member may die of the disease.

Unhealthy environment particularly predisposes to tuberculosis; and the element of poverty—leading as it does to taking improper or insufficient food, dwelling in an unhygienic room or in an overcrowded building, pursuing an exhausting occupation, working for long hours, and obtaining insufficient amusement and outdoor exercise—also has a most powerfully unfavorable effect. As a class the poor dislike ventilation, take insufficient exercise in the open air, do not get enough sunlight, work in a dusty atmosphere, take insufficient nourishment and eat improper food, live in damp and dirty rooms, are subjected to grinding competition and cruel anxieties, and many of them drink quantities of whiskey. City life is a predisposing cause of tuberculosis for many of the foregoing reasons, and particularly because many city workers follow an indoor occupation. The enemies of tuberculosis are sunlight, fresh air, nourishing food, and outdoor exercise, and the limiting of any of these factors favors the development of the disease.

Tuberculosis may occur in any region that man inhabits; although in some regions it is rare, and in others it is excessively common. Its great frequency in some regions is probably due less to climate than to environment, occupation, and heredity; and the greatest predisposition is found in the town dweller. There is much more tuberculosis among males than among females.

An injury may be followed by the development of tuberculosis at the seat of injury, the injury creating a point of least resistance in which bacilli may lodge. A slight injury of a joint or a bone is the most common traumatic predisposition; although a chest injury may be followed by tuberculous pleuritis, and a head injury by tuberculous meningitis. The injury that predisposes, as previously stated, is a trivial, and not a severe one. In some cases in which tuberculosis develops after injury, the injury has been a mere coincidence; in others, a region the seat of an undeveloped tuberculosis has been affected by the injury, and the tuberculous process has thus been awakened into activity. If there is no tuberculous focus at the seat of injury, we are justified in concluding, when tuberculosis develops, that a point of least resistance has been created. Such points are more common in those that have a focus of tuberculosis somewhere about the body, but may apparently occur in those that have no such focus. Many diseases and conditions predispose to tuberculosis. Tuberculosis is very common in chronic drunkards, in the insane. in the occupants of prisons, almshouses, and reformatories; among negroes in the north, particularly those engaged in indoor occupations; among American Indians subjected to the blighting influences of civilization by formula and toutine; and in the sufferers from tertiary syphilis, diabetes, and Bright's disease. Any exhausting malady may be followed by tuberculosis.

The Term Scrofula.—Many surgeons positively oppose the use of the term scrofula, but I believe that there is clinical value in retaining it. The surgeons that have entirely abandoned it think that, after all, it is exactly synonymous with tuberculosis. I use it to designate the persons that are predisposed to tuberculosis through possessing a type of tissue of low resisting power. These tissues fall a ready prey to the bacteria of tuberculosis. Such tissue-vulnerability is usually hereditary; and, as a rule, one, or even both parents are tuberculous, are in ill health, or are themselves predisposed. Occasionally this type of tissue is acquired, a child having at first been apparently entirely healthy; and later, owing to poor food, insufficient air, and bad hygienic surroundings, developing scrofula.

That scrofula is not simply osseous, articular, or glandular tuberculosis is proved by the fact that a person that we recognize as scrofulous may never throughout his life develop a tuberculous lesion. Some surgeons think that scrofula is latent tuberculosis, and will, under the influence of some exciting cause, burst into activity. This is possible, but unproved. We do know that some so-called scrofulous lesions are not tuberculous; for instance, facial eczema, corneal ulceration, granular lids, and mucous catarrh. These lesions are rather expressive of poor health, improper food, and deprivation of fresh air.

The subjects of scrofula, besides being prone to the non-tuberculous lesions above mentioned, are particularly prone to develop tuberculous lesions; and such a lesion may arise in any part that has been the seat of a slight injury or of a non-tuberculous inflammation. The parts most apt to become tuberculous are the bones, the joints, and the glands.

There are two types of the so-called scrofulous, that is, two types of those that are predisposed. The common type is known as the *phlegmatic*, or *lymphatic*; and it is this type that is particularly described by our surgical forefathers. In the phlegmatic type, the individual is stolid of expression;

and has thick, coarse skin, a muddy complexion, dark, coarse hair, a thick neck, thick lips, a thick nose, and a heavy lumbering gait. He is dull of apprehension, with feeble emotional reaction, and but little capacity for concentration or interest. The other type is much more seldom met with. It is what is called the sanguine type, or what the elder Gross spoke of as the angelic type. Such a child is frequently beautiful, and graceful in its movements. Its skin is transparent and clear, and the color comes and goes. The eyes are blue, the lashes long, and the hair silky. The tendency is to thinness, rather than fat; and the mind is not dull, but precocious and the temperament is nervous. In both these types of scrofula, the condition of lymphatism exists.

Lymphatism, or the Lymphatic Constitution (Status Lymphaticus).—This term was introduced by Potain to designate a condition in childhood in which there is a very strong disposition to the development of disease of the lymphatic structures, or in which at birth there was excessive development of these structures. The enlarged glands may be tuberculous from the beginning; but, as a rule, they are not so in the beginning, but tend to become so. Inflammation of a mucous membrane is followed by enlargement of the anatomically related lymphatic glands. These enlarged glands are frequently met with in the neck. We find them associated with enlarged

tonsils and pharyngeal adenoids.

Usually lymphatism is congenital, but it may be acquired when children are placed under unfavorable conditions. Lymphatic children frequently have rickets and are invariably anemic. In infancy it is the bronchial and mesenteric glands that are particularly apt to enlarge; in childhood, it is the glands of the neck. In lymphatic children it is not uncommon to have a persistent thymus gland. The gland, however, is not obvious, but rather hides at the root of the neck (Humphry, in "Lancet," Dec. 26, 1908), and may be missed at necropsy. In some cases a goiter appears. As the child increases in age, the lymphatic enlargements are likely to disappear unless tuberculous infection has occurred. After a child has reached the age of seven or eight years non-tuberculous glands of the neck cease to enlarge; and by the time of puberty they have usually disappeared. I do not believe that the condition can be diagnosticated during life.

If an operation is performed on the victim of lymphatism the wound is very liable to become infected, and the bleeding from the wound is very trivial. The victims of lymphatism are more apt than other persons to die under a general anesthetic, and occasionally one of them dies during natural sleep (see Dr. Geo. Blumer, in the "Bulletin of the Johns Hopkins Hospital," Oct., 1903). This disease accounts for most otherwise inexplicable cases of sudden death in children and young persons, and such deaths are respiratory

and not cardiac (Humphry, in "Lancet," Dec. 26, 1908).

The Diagnosis of Tuberculosis.—Whenever he sees a persistent area of chronic inflammation in any structure of the body the surgeon must think of the possibility of its being tuberculous. A thorough investigation must be made into the local disease and the body generally; and it is of particular importance to determine whether there is any other diseased locality, and whether there is any evidence of tuberculous disease anywhere in the body. The patient's history must be investigated, and any possible tendencies or predispositions inquired into. Tuberculosis does not cause leukocytosis

except, perhaps, occasionally and moderately in tuberculosis of serous membrane, and even in this condition there is no increase in polymorphonuclear cells. A mixed infection causes only a trivial increase in polynuclear leukocytes.

In many cases of tuberculosis, the diagnosis can be made from purely dinical investigation. This is the case, for instance, in many tuberculous ulcers, abscesses, and glands. In some cases the diagnosis can be made only by making differential stains of material obtained from the suspected focus, or by removing a section of the inflammatory area with a Mixter's canula, and studying it carefully under the microscope. Cultures may be taken from any material obtained from the suspected focus.

In doubtful cases, animal inoculation is necessary to make a diagnosis. The material is injected into a guinea-pig; and if it be tuberculous, the animal will develop miliary tuberculosis within a few weeks. With apparently sterile fluid obtained from a tuberculous focus, the disease can be induced in guinea-pigs by inoculation. Blistering a tuberculous person causes elevated temperature (page 236). If the fluid of the blister be injected into a tuberculous

animal a distinct reaction occurs (page 236).

In a suspected case of tuberculous meningitis of the brain or of tuberculous disease of the membranes of the cord, the theca of the cord should be tapped (lumbar puncture), and the fluid obtained should be carefully examined. Of course, if, in a case of tuberculous cerebral meningitis, the foramina in the floor of the fourth ventricle have been blocked by exudate, no characteristic fluid will be obtained by tapping. It is usually found, however, that even in tuberculous cerebral meningitis, there is increased tension of the fluid in the subarachnoid space of the cord, that this fluid is present in unnaturally large quantity, and that it is turbid through the presence of pus and white blood-cells. Sometimes it contains bits of fibrin and sometimes blood; and in many cases the bacilli of tuberculosis. Exploratory abdominal incision is sometimes necessary to determine the existence of tuberculous peritonitis.

The x-rays are of great aid in making a diagnosis of osseous, articular, and, perhaps, certain forms of pulmonary tuberculosis. The area of tuberculosis is lighter than the surrounding healthy structures when seen by the x-rays.

The Tuberculin Test.—The tuberculin test may sometimes be used to very great advantage in making an early diagnosis of recent lesions. Some physicians will not use it, believing that it is very dangerous. However tuberculin is used, it is much more reliable diagnostically in children than in adults. In many adults free from demonstrable signs of tuberculosis, tuberculin gives a distinct reaction probably because many adults have or have had the disease. I have already expressed the belief that if given in moderate doses it is safe; that is, it is safe if the disease is not too far advanced. Very large doses, or the giving of the remedy at all in greatly advanced tuberculosis, would not be safe. Some conditions contraindicate its use, among them are the following: Addison's disease, recent pulmonary hemorrhage, and suspected bilateral renal tuberculosis (Howes and Floyd in "Publications of Mass. Gen. Hospital," 1908). It should only be given when other diagnostic Dethods fail to give certain information, and is only to be used by a man trained in its use. Too large a dose may cause a severe chill, high fever, and Meat exhaustion, may arouse a latent focus to activity, and may actually cause dissemination of the disease. There is no use in trying the test if fever exists.

A temperature of 99.5° F. or over, when the patient is quiet in bed, contraindicates the employment of the test. The test should be used as directed by John B. Howes and Cleveland Floyd ("Publications of the Mass. General Hospital," 1908). These rules are as follows: Koch's old tuberculin is used and the preparation must not be over two months old. One cc. (100 mg.) of the material is drawn up in a pipet and is dropped into 10 cc. of a ½ per cent. solution of carbolic acid. Each cubic centimeter of this solution contains 10 mg. of tuberculin; 1 cc. of solution No. 1 is mixed with 9 cc. of a ½ per cent. solution of carbolic acid. Each cubic centimeter of solution No. 2 contains 1 mg. of tuberculin.

One cc. of solution No. 2 is mixed with 9 cc. of the very dilute carbolic solution. Each cubic centimeter of solution No. 3 contains .1 mg. of tuberculin.

The patient is kept in bed for three days before beginning the test, and also during the test, and during all of this time the temperature is taken every two hours. The injection is to be made at an indifferent point. The first dose is 1 mg. of tuberculin (1 cc. of solution No. 3). If there is no reaction, wait for three days and then give 1 mg. (1 cc. of solution No. 2). If No. 2 gives no reaction, wait three days and give 10 mg. (1 cc. of No. 1 solution); if it gave a slight reaction, inject 5 mg. (\frac{1}{2} cc. of No. 1 solution). The reaction sought for is not only rise of temperature, but local signs and constitutional symptoms.

We have previously described the tuberculin reaction; that is, the temporary local congestion or inflammation in the tuberculous area, and the chilly sensation or chill, followed by marked elevation of temperature. The local reaction is the most important. In certain tuberculous lesions we can see the local reaction; for instance, in lupus. In joint tuberculosis the skin over the joint becomes red. In a tuberculous ulcer of the mouth we can see the changes; and in a lesion of the larynx the laryngologist can observe them with the laryngoscope. By means of a cystoscope the local reaction can be seen in a tuberculous ulcer of the bladder.

Troudeau pointed out that redness at the seat of injection is a common reaction. The constitutional signs of reaction are chilly sensations or chills, sweats, skin eruptions, headache, pain in the back and joints, diarrhea, nausea, malaise, cardiac palpitation, and dyspnea. Howes and Floyd regard even ½° F. of fever as significant of reaction if there are also constitutional symptoms and local signs.

The tuberculin test should not be used in advanced pulmonary tuberculosis because it is unsafe. In advanced cases it fails to cause any reaction because the tissues are unable to produce antibodies when acted on by toxin (Howes and Floyd, in "Publications of the Mass. General Hosp.," 1908). As a matter of fact, there is never any need of using the test in an advanced case, because the diagnosis is perfectly clear without it. We never should give extremely large doses in making the tuberculin test, because an extremely large dose may obtain a positive reaction even in a healthy man. A person with actinomycosis or secondary syphilis may show a reaction to tuberculin which confuses our results. There may be no reaction to tuberculin when a tuberculous focus is encapsuled with thick walls. If, after the careful use of tuberculin, there is no reaction, it is usually a safe conclusion that there is no tuberculosis.

The Ophthalmo-tuberculin Reaction.—It was pointed out that when tuberculin is injected into a tuberculous individual a reaction arises at the seat

of injection. It has been shown that if tuberculin is placed in the conjunctival se of a tuberculous individual a reaction occurs, and this method is valuable because even a trivial reaction is easily observed. The introduction of tuberculin into the conjunctival sac is usually spoken of as Calmette's method. This test can be used even if fever exists and even if a skin eruption exists. It is not as satisfactory in surgical as in medical cases. The old tuberculin of Koch is used. It is carefully freed from irritant materials, a 1 per cent. solution is made in normal salt solution, and 1 drop of this is placed in the eye. Baldwin regards 1 per cent. as dangerously strong and uses ½ per cent. No constitutional symptoms develop, but in four or five hours, if the subject be tuberculous, the conjunctiva of the lids becomes injected, the corneal vessels distend, lachrymation arises, and the lids may swell (Howes and Floyd, in "Publications of Mass. General Hospital"). The reaction attains its height in from twelve to twenty-four hours and disappears in from forty-eight to seventy-two hours after its first appearance. In a non-tuberculous person no redness, or only a trivial and temporary redness, is noted. There is never a constitutional reaction even in a case of advanced tuberculosis. Of course, this test is contraindicated if there is a tuberculous lesion of the lids or eye, if there isulceration of the cornea, or if conjunctivitis exists, I have never become convinced that the method is entirely free from danger to the eye, and I own that I rather fear to use it. Cases of permanent ocular injury are on record. Baldwin (" Jour. Am. Med. Assoc.," February 20, 1909) made over 1000 tests. He says that the test has some value in diagnosis, no value in prognosis, and as yet cannot distinguish "active latent" from healed tuberculosis. He says danger to the eye is slight.

Von Pirquet's Cutaneous Tuberculin Reaction.—After the skin has been rawed or scarified, 1 drop of Koch's tuberculin is put upon the abraded surface. In a tuberculous individual local redness will appear in ten or twelve hours, and in twelve hours more the area will be swollen and perhaps edematous. This condition disappears in a few days, leaving, perhaps, as a legacy a trivial induration. There is almost never a febrile reaction.

Moro's Cutaneous Tuberculin Reaction.—The material used is 5 cc. of old tuberculin and 5 gm. of lanolin. It is rubbed into the abdominal skin and if the individual is tuberculous a crop of red papules appears in the area where the inunction was made. There is no febrile reaction.

Blistering a Tuberculous Person.—See page 236.

Injecting a Tuberculous Animal with Blister Fluid from a Person

Suspected to be Tuberculous.—See page 236.

Massage of a Tuberculous Focus.—Wright has shown that gentle massage of a tuberculous focus may be followed by a reaction like that which follows the diagnostic use of tuberculin. In such a case the massage drives tuberculous products into the blood and, perhaps, if the massage is frequently repeated, auto-immunizes the individual.

Animal Inoculations.—This method of diagnosis is seldom employed

and only in unusually obscure cases.

The Agglutination Test.—The agglutination test, as applied to the blood-erum of a tuberculous individual, is decidedly uncertain.

Finding Bacilli in the Blood (Rosenberger's Method).—The finding of tubercle bacilli in the blood by the method of Rosenberger is proof of the

existence in the body of the bacilli of tuberculosis. The method is entirely free from danger or unpleasantness to the patient, and, if Rosenberger's favorable conclusions secure confirmation, it is the method of all methods for making the diagnosis. About 5 cc. of blood are drawn from a vein in the arm and it is placed at once in an equal quantity of a 2 per cent. solution of sodium citrate in normal salt solution. The mixture is shaken thoroughly and is placed in a refrigerator for twenty-four hours. Some of the sediment is then removed by means of a pipet, a thick preparation is made upon a glass slide, and the slide is dried upon a copper plate at a moderate heat, and is then placed in distilled water until complete laking occurs. The delicate film which remains is dried and fixed by passing through the flame of a Bunsen burner and is then stained by the technic in common use to stain tubercle bacilli ("Am. Jour. Med. Sciences," Feb., 1909). Rosenberger's studies upon cases in my wards in the Jefferson Hospital have proved most helpful to me, and I believe that his views are correct.

Prognosis.—Many cases of tuberculosis are cured. This is indicated by the frequency with which we find healed tuberculous lesions in necropsies on individuals dead of other diseases. We reach the same conclusion from the clinical study of many cases. The prognosis of a single tuberculous focus, especially if it can be extirpated or sterilized, is very good; provided that the general health is good, that there is not much anemia, that the digestive processes are well performed, that mixed infection is absent, that there are no albuminoid changes in the viscera, and that the patient is able and willing to live the life that is necessary for his welfare. Of course, the prognosis is influenced by the patient's temperament, his willingness to brook control, his monetary status, and his habits. The danger is greatly increased by multiple lesions. The dangers of mixed infection and of albuminoid disease have been previously discussed.

In very young children the prognosis is most unfavorable; but in older children it is very much better; in fact, it is better in them than in adults.

Tuberculosis of the skin gives a very fair prognosis; and glandular, bony, and articular tuberculosis are frequently recovered from: but, of course, any tuberculous lesion, however limited in area, is a profound menace.

Another fact to be borne in mind is that many cases apparently cured are not really cured; and that the disease strongly tends to reappear in the same region or in a nearby region, or to reappear later in another part of the body. We should, further, remember that in many cases in which there is apparently one lesion only, there are, in reality, distant lesions undiscoverable by clinical methods. In any case of tuberculosis the higher the opsonic index the better the prognosis, the lower the opsonic index the worse the prognosis

(page 41).

Another important fact is that when an individual has a latent focus of tuberculosis, especialy if this latent focus is in the lungs, should a surgical operation be performed for some other purpose, and the patient be kept in bed for a considerable length of time, the latent focus may become active. I have always believed that in latent pulmonary tuberculosis the administration of ether or chloroform might waken the disease into activity. It therefore becomes evident that in such persons operations of necessity are the only ones that should be undertaken. Such an operation, if possible, should be

done under a local anesthetic; and the patient should be got about again at the earliest possible moment.

Treatment.—One of the first thoughts of the surgeon is to provide against the contamination of healthy individuals by the infected. Any infected excetion or suspicious discharge from the patient must be disinfected at once and dressings that are removed from the patient should be burned.

We are not in this section discussing the treatment of tuberculosis of the lungs, which belongs to the medical man, and in which climate is of the first importance. In cases of surgical tuberculosis, however, the patient may do better in some climates than in others; and the change, by stimulating the appetite and causing him to sleep and giving him renewed hope, will be beneficial. In surgical tuberculosis, climate is not the factor that it is in tuberculosis of the lungs; but if there is pure atmosphere, an equable temperature, and plenty of sunlight, the climate will lure the patient out-of-doors, and will thus begreatly to his advantage.

A life in the open air is the most essential thing in the treatment of surgical tuberculosis; but, as Professor Halsted points out, it is not of much use to tell a great many persons to live in the fresh air. They will not do it, unless they are made to; and it is hard to make them unless they live in quarters especially built with this object in view. Therefore, other things being equal, if the patients with surgical tuberculosis have the means, it is a good plan to send them to a sanitarium in the mountains or at the seashore, where they can obtain the persistent, unbroken life in the open air that is the cure of the disease. The patient should spend his days in the fresh air, and he should sleep at night directly exposed to the air; and if the atmosphere is free from dust and foul odors, so much the better. The poorer patients must get the fresh air at home, if they cannot be sent to some camp or colony. In large cities adjacent to the seaside resorts, poor people can usually be sent for a short time, at least, to the seaside; and I am a very great believer in the beneficial effects of Atlantic City and other seashore resorts.

It is frequently necessary to do an operation in a great city, although we operate much less than formerly for these conditions. If an operation is done in a great city, the patient is kept in the fresh air as much as possible during his convalescence. If it is feasible, he is sent away to a colony or sanitarium to recuperate. It would be an excellent thing if, in many of those cases in which operation is necessary, the operation could be performed at the camp or the sanitarium. One advantage of the camp or sanitarium is that the patient is watched and regulated daily, and is led to do things that otherwise he would neglect. Many patients endeavor to evade going out when they should, because they are afraid of taking cold; and many of them are just neglectful and do not want to take the trouble to do it.

It cannot be too strongly insisted on that in surgical tuberculosis fresh air is of as much importance as in tuberculosis of the lungs. It increases the vital resistance, it stimulates opsonic power, and it causes the patient to eat more nourishing food and to sleep better at night. Frequently we see children that have had sinuses for months get rapidly well when they adopt an open-air life; and, although albuminoid changes, when they once exist, will never pass away, further albuminoid changes may not take place if the patient lives properly.

A patient with surgical tuberculosis can have no more injurious environment than a dark, damp room, especially if it is in a crowded tenement and up a narrow court. The value of sunshine is also beginning to be appreciated. We know that it limits the growth of tubercle bacilli. It is not the heat that benefits the person, but the chemical rays of sunlight. These rays have some germicidal influence, have considerable penetrating power, and seem to influence decidedly the nutritive processes. Excessive sunlight is, however, not beneficial. In summer it exhausts the patient and even in winter it produces eye-strain and headache. Major Woodruff, U. S. A., insists that excessive sunlight is actually harmful, particularly to blondes ("The Effects of Tropical Light on White Men"). Tuberculosis is dreadfully fatal in certain tropical countries and is more fatal to blondes than to brunettes. Open air treatment is more valuable in winter than in summer, perhaps because cold stimulates respiration and because the sunlight is not debilitating.

The area of tuberculosis requires rest. We have long known how disastrous it is to confine a person to bed in a dark, ill-lighted, and improperly ventilated room. We can, however, confine a person to bed with perfect safety if there is a free flow of fresh air. We must confine certain cases to bed; for instance, cases of tuberculous peritonitis, and some cases of bone tuberculosis, and of joint tuberculosis. A patient with tuberculosis who has fever ought to be in bed. We can put such patients to bed without any fear of the disease becoming worse or spreading if the supply of fresh air is plentiful and if the patient is kept warmly covered and wears a skull-cap. Of course, a draft is to be avoided. Patients that are confined to bed do excellently in a tent, in a cottage sanitarium, or on a porch that has been altered for the purpose.

At the very first possible moment the patient should be got out-of-doors; and in many cases of tuberculous disease (for instance, vertebral disease),

the tuberculous part is supported by means of a brace or a splint.

We thus see the two-fold nature of the modern treatment of surgical tuberculosis: rest for the tuberculous part and a life in the open air. Exercise is of importance also, although it should never be taken in excess. If the patient is confined to bed, he should be massaged and rubbed with alcohol, the tuberculous part being usually avoided. Forcible manipulation must never be applied to a focus of tuberculosis, because it may lead to dissemination. Gentle massage of a tuberculous part may do good. Wright has shown that it is followed by a reaction like that produced by tuberculin and is due to the absorption of tuberculin from the seat of disease. If a person has fever he must not attempt active exercise, but must be confined to bed.

One should overfeed tuberculous patients, if the stomach tolerates it; but not on any single article, or even on any particular one. The diet should contain a sufficiency of fats, proteids, and carbohydrates; and the food should be agreeable to the taste and readily assimilable. Otherwise, disgust will be engendered; and with disgust comes indigestion and loss of appetite. The very life of the patient may depend on his remaining able to take a sufficiency of nourishing food.

There is no specific diet for tuberculosis, although many have been suggested. One of the most valuable foods is milk, taken raw or mixed with other articles, such as lime water or sodium carbonate, and frequently with brandy. The use of an exclusive diet of boiled milk is to be deprecated, and in

children it sometimes leads to the development of scurvy. Practically anyone can take milk, if proper efforts are made.

Soft boiled eggs are useful; and bread or toast should be eaten with plenty of butter, which is an agreeable form of fat. Vegetables and fruits are desirable.

If the patient can take cod-liver oil without impairing his appetite or digestion, it should be given; provided the weather is not too hot. Cod-liver oil produces diarrhea in very hot weather. Children learn to take it very well. To many adults, however, it is, and remains, absolutely abhorrent. The chief value of cod-liver oil is that it is a fat, and it seems improbable that it contains any elements specifically antagonistic to tubercle. If used, large doses should not be given; as they will not be digested. The common dose for an adult is a teaspoonful two or three hours after meals. Thirty drops three times a day is usually given a child, and an infant should receive 15 drops three times a day.

We know of no drug or medicine that can with safety be used at the present time with any real hope that it will specially destroy tubercle. Drugs are, of course, given, but they are of secondary importance.

Tonics are used, and in children the syrup of the iodid of iron has considerable reputation. Remedies may be needed to improve digestion or control night-sweats, etc. I do not believe that beechwood creosote or carbonate of guaiacol internally, or iodoform inunctions, or painting the surface with guaiacol confer any real benefit in tuberculosis.

Alcohol is often required. It is not needed in all cases, but is in many. We should avoid it in children, however, unless there is a particular indication for its use. When a tuberculous patient is weak, milk-punch or egg-nog is of service; and in any case of mixed infection alcohol is required in full doses. If fever exists, and the administration of alcohol makes the pulse more rapid and the delirium worse, and causes flushing of the face, the dose is too large and should be diminished. Any patient that smells strongly of alcohol is getting an overdose. Many able investigators in many lands are striving to work out a safe and satisfactory specific treatment for tuberculosis. Landerer proved that immunity to tuberculosis can be produced in the lower animals by injection of living bacilli. Injections of tuberculin finally produce immunity to that product. Just at present we are witnessing a revival of faith in tuberculin.

One set of clinicians begin with very small doses and by a very gradual increase of dose finally reach full doses. The object is to produce an immunity to tuberculin.

When an animal becomes immune to tuberculin the body cells resist and smally destroy the tubercle bacilli (Braun, in "Boston Med. and Surg. Jour.," July. 23, 1908). The treatment is begun with doses of .0001 mg. of the new tuberculin emulsion of Koch (B. E.) or .001 mg. of the old tuberculin (T. O.). The dose is gradually but very slowly increased, the effort being always to increase with the smallest possible disturbance. Finally, full doses are given. From six months to a year is required for the treatment. If the bacillary mulsion is used, no reaction need be obtained throughout treatment. The escence of treatment is the very small dose and the very gradual increase. The utterly reckless use of tuberculin when it was first introduced lead to most disastrous results and consequent abandonment of the treatment until three or

four years ago. It was not that tuberculin treatment was wrong, but that too large doses were given and were given indiscriminately to any and all tuberculous patients.

Wright gives very small doses of emulsion of powdered bacilli, not with the idea of causing body immunity to tuberculin, but to produce immunity by

strengthening the phagocytic power of the leukocytes.

When this plan is followed the dose is determined by the opsonic index. and the dose is only raised to a sufficient degree to establish the positive phase without producing even the most trivial subjective symptoms. One dose causes an increase of immunizing power in the body for about a fortnight and then another dose is given. Many clinicians deny the need of even giving the dose by the opsonic index. When tuberculin is given by either of the above plans it is entirely safe, and I believe, beyond doubt, is of value in suitable cases. It is not to be used in advanced cases or in febrile conditions. It must be given in doses so small that it causes no reaction and no marked local reaction at the seat of disease. For tuberculous glands, tuberculous bones, or tuberculous joints, one dose a week is given. It is injected hypodermatically beneath the skin of the back. If we get a general or local reaction, the dose is too large. When given in this way it is safe, never produces trouble at the site of injection, seems to arrest some cases of tuberculosis, improves the local trouble in many, and benefits the general condition of most. According to Trudeau, tuberculin strengthens the individual's immunity to tuberculosis. According to Wright it causes an increase in deficient opsonins. Tuberculin is of unquestionable value in some cases of lupus.

Ringer has recently strongly advocated the use of tuberculin ("Jour. Am. Med. Assoc.," May 2, 1908). Maragliano treats tuberculosis with the serum of animals which have been injected with dead bacilli and toxins, and he believes that this serum contains quantities of antibodies and antitoxins. The animal is injected many times until its serum becomes highly agglutinative. Maragliano believes that this highly agglutinative serum when introduced into the human body causes the protective mechanism of the body to produce quantities of antibodies and antitoxins. Most clinicians do not favor the use of

Maragliano's serum.

The Local Treatment of Tuberculosis.—When certain drugs are directly inserted into a tuberculous focus, they do possess an antagonistic influence. Iodoform is the most powerful of these drugs; guaiacol, balsam of Peru (Landerer), bismuth, and chlorid of zinc (Lannelongue) have a similar action. Iodoform has little or no influence when placed on a free surface exposed to the air, but when in the form of an emulsion it is injected into a tuberculous area, the air being excluded (page 30), this drug is powerfully antituberculous. Chlorid of zinc seems to act by causing the development of quantities of fibrous tissue, which encapsulates or, perhaps, replaces the tuberculous focus. Some surgeons inject tuberculous nodules with camphorated naphthol. Every region of tuberculosis requires local rest, perhaps by the use of a splint, or a brace.

Special Methods of Surgical Treatment.—The surgeon may endeavor to extirpate a tuberculous focus, or to drain it thoroughly and to sterilize the area. Extirpation is sometimes, although not very frequently, possible. Complete extirpation is a valuable method, but partial extirpation is dangerous.

If a part only of a tuberculous focus is extirpated, many lymph-tracts and bloodvessels are opened; and the incomplete operation may lead to the dissemination of the disease. The methods of surgical treatment suited to different forms of tuberculous disease will be discussed in different sections of this book.

Bier's Method by Congestive Hyperemia (see page 116).—Bier believes that passive hyperemia is of the greatest possible benefit. Active hyperemia is obtained by heat, and is especially valuable to induce the absorption of the products of a non-tuberculous chronic inflammation. Passive hyperemia is particularly useful in tuberculosis of joints, tuberculous ulcers, cold abscesses, and tuberculous disease of the tarsus and carpus and phalanges. If a limb is affected, it is obtained by placing a rubber band around the limb above the part, the band being applied with sufficient firmness to interfere with venous return, but not so tightly as to block arterial entry. This band should be applied daily, and should be kept in place for an hour or so at each application. In the intervals between the treatments the limb should be at rest. Bier uses special apparatuses for obtaining congestive hyperemia in various parts of the body.

I have seen cure or very great improvement follow this treatment in a number of cases. It is founded on the old idea of Laennec that cyanosis and tubercle are antagonistic. Why this method is beneficial is much debated. Some think that the imprisoned blood takes on increased bactericidal power; some, that the number of leukocytes is greatly increased; some, that quantities of leukocytes migrate; and some, that the amount of bactericidal blood-serum is increased. Bier believes that it depends upon phagocytosis. It would seem possible that the cells in this locality, under the influence of the congestive hyperemia, may form powerful antitoxins.

The Finsen Light.—Finsen pointed out that the chemical rays in sunlight are powerfully germicidal, and that this germicidal power can be notably increased if the rays are concentrated on a part by the use of particular apparatus. Healso showed that enormous numbers of chemical rays can be obtained from electric light. The Finsen treatment to-day consists in applying the actinic rays obtained from electric light. They act most powerfully on lupus, but require a very long time to effect a cure.

The X-Rays.—The x-rays are of value in treating certain tuberculous conditions. They are of most use in lupus, their effects in this disease being nearly as powerfully curative as those of the Finsen light, and much more rapid.

Tuberculous Abscess.—For description of this see page 155.

Tuberculosis of the Skin.—Tuberculosis of the skin may arise from inoculation with material derived from a bovine or human source. It is frequently found that some other member of the family labors under tuberculous disease or that some family predecessor, direct or collateral, suffered from it. Stelwagon ("Diseases of the Skin") includes all cases under five heads: (1) tuberculosis ulcerosa; (2) tuberculosis disseminata; (3) tuberculosis verrucca; (4) scrofuloderma; (5) lupus vulgaris.

Tuberculosis Ulcerosa.—The disease arises by a mucous outlet and is usually secondary to internal tuberculous disease. Small miliary tubercles form which caseate and are converted into ulcers. The ulcers are shallow, round or oval in outline, with soft edges, the floor being composed of sluggish or edematous granulations covered with a crust. The discharge is scanty and

seropurulent. In some cases there is but one ulcer; in others there are two or several, and the fusion of ulcers produces a serpiginous outline. The ulcers do not tend to heal, but gradually and steadily advance. Such ulcers are met with about the mouth, the genital organs, and the anus.

Tuberculosis Disseminata.—This occurs only in children; it is acute in onset and widespread. One type is polymorphic: spots, papules, pustules, and crusted ulcers existing, and lymphatic glands being enlarged. Another type follows one of the exanthemata and presents "a rough resemblance to flat lupus tubercles, to sluggish acne papules, and to lichen scrofulosum" (Stelwagon).

Tuberculosis Verrucosa.—Anatomical tubercle, the verruca necrogenica of Wilks, is due to local inoculation with tuberculous matter. It may be met with in surgeons, the makers of post-mortems, leather-workers, and butchers, usually upon the backs of the hand and fingers. It consists of a red mass of granulation tissue having the appearance of a group of inflamed warts. Pustules often form.

Scrofulodermata or tuberculous gummata.—By scrofulodermata we mean chronic inflammations of the skin, the granulation-tissue product of which caseates, mixed infection occurs, and small abscesses, sinuses, or ulcers form. A tuberculous ulcer has a floor of a pale color, and has no granulations at all, or is covered with large, pale, edematous granulations. The discharge is thin and scanty. The ulcer is surrounded by a considerable zone of purple, tender, and undermined skin, which is apt to slough. When healing occurs, the skin puckers and usually inverts.

Lupus.-Lupus begins usually before the age of twenty-five, but is met with often in individuals in middle life. It is most usual upon the face, especially the It is a very chronic and extremely destructive disease. Three forms are recognized: (1) lupus vulgaris, in which pink nodules appear that after a time ulcerate and then cicatrize partly or completely. These nodules resemble jelly in appearance; (2) lupus exedens, in which ulceration is very great; and (3) lupus hypertrophicus, in which large nodules or tubercles arise. Lupus may appear as a pimple, as a group of pimples, or as nodules of a larger size. The ulcer arises from desquamation, and is surrounded by inflammatory products which, by progressively breaking down, add to the size of the raw surface. The ulcer is usually superficial, is irregular in outline, the edges are soft and neither sharp nor undermined, the sore gives origin to a small amount of thin discharge, the parts about are of a vellow-red color, the edges are solid and puckered and scar-like and there is no pain. The sore is often crusted, the crusts being thin and of a brown or black color; it may be progressing at one point and healing at another; it is slow in advancing, but often proves hideously destructive. The scars left by its healing are firm and corrugated, but are apt to break down. Clinically it is separated from a rodent ulcer by several points. The rodent ulcer is deep, its edges are everted, and the parts about filled with visible vessels. It is not crusted, has not a puckered edge, its edges and base are hard and rarely show any tendency to healing.

Tuberculosis of Subcutaneous Connective Tissue.—In this form of tuberculosis tuberculous nodules form and break down (tuberculous abscesses). In the deeper tissues these abscesses are usually associated with bone, joint, or lymphatic gland disease (see Cold Abscess, page 155).

Tuberculosis of the Mammary Gland.—(See page 163.)

Tuberculosis of Blood-vessels.—It is certain that bacilli in the blood or in tuberculous emboli may establish intravascular tuberculosis.

Tuberculosis of nerve is excessively rare. Tuberculous neuritis may arise in the course of general tuberculosis. A nerve lying in a tuberculous are may itself become tuberculous. It rarely does so, however. In fact, nerves resist infections though in the midst of them, and for this reason have been called the "aristocrats of the body."

Pulmonary Tuberculosis.—In adults the lungs are more commonly affected than any other structure. The lung affection may be primary or may be secondary to some distant tuberculous process. Pulmonary tuberculosis belongs to the province of the physician and requires no description here.

Tuberculosis of the Alimentary Canal.—A tuberculous ulcer of the lip occasionally arises, and may be mistaken for a cancer or a chancre. A tuberculous ulcer of the tongue is commonly associated with other foci of disease. Such ulcers are separated from cancer by their soft bases and edges and by the rarity of glandular enlargements, and from syphilitic processes by the therapeutic test. Confirmation of the diagnosis is obtained by cultivations and inoculations. Tubercle may affect the pharynx, palate, tonsils, and, very rarely, the stomach.

Gastric Tuberculosis.—It is thought that the acid gastric juice must protect the stomach from tubercle, because tubercle bacilli are frequently introduced into the stomach, but the organisms very rarely lodge and multiply in the stomach-wall. Furthermore, bacilli when introduced into the stomach are retained but a short time and the stomach-walls contain few lymph-follicles Barchasch, in "Beit. Z. klin. d. Tuberculose," vii, Part III, 1907). It may be assumed that gastric catarrh and motor impairment are predisposing causes. Gastric tuberculosis may be primary, but is usually secondary to pulmonary unberculosis, infected sputum having been repeatedly swallowed ("Jour. Am. Med. Assoc.," Dec. 28, 1907). Gastric tuberculosis may cause cicatricial stenosis of the pylorus, ulcer (of which I reported an instance), a tumor-like thickening, solitary tubercle, and miliary tuberculosis (Barchasch, Ibid.).

Intestinal tuberculosis may follow pulmonary tuberculosis, but it may arise primarily in the mucous membrane of the bowel or result from tuberculous peritonitis. Intestinal tuberculosis causes diarrhea and fever, may resemble appendicitis, and may cause abscess and perforation. True tuberculous disease of the appendix occasionally occurs. Tuberculosis of the cecum is by no means as rare as we used to believe (page 996). Fistula in ano is frequently tuberculous, and when it is, the lungs are very often involved, the pulmonary lesion being usually primary (page 251).

Tuberculosis of the Liver.—Tuberculous disease of the liver causes old abscess or cirrhosis.

Peritoneal tuberculosis (page 1008) may be primary, infection having been by way of the blood, may be part of a diffused process, or may follow intestinal tuberculosis, the serous and muscular coats of the bowel having been at tome point in contact or a follicular ulcer having perforated (Abbe). The germ may have entered by the Fallopian tube. Tuberculous peritonitis may be due to oration or Fallopian tuberculosis, or to ulceration of a tuberculous appendix. It usually causes ascites, tympany, and tumor-like formations composed of adherent bunches of bowel or omentum or distended mesenteric glands (page 1008).

The **heart muscle** is rarely attacked by tuberculosis. In fact, valvular lesions of the left side of the heart actually protect the individual from pulmonary tuberculosis. Non-tuberculous endocarditis may arise in the course of a tuberculous process elsewhere. Tuberculous endocarditis does *very rarely* occur.

The pericardium may be attacked with primary tuberculosis, or the

process may be secondary to pleural tuberculosis.

Tuberculosis of the pleura is not uncommon. Tuberculous pleurisy may be acute or chronic. In some instances mixed infection takes place and suppuration occurs. The tuberculosis may be primary, but is usually secondary to pulmonary tuberculosis, and may be due to direct extension or to rupture of an area of pulmonary softening. A primary pleurisy not due to traumatism is very apt to be tuberculous.

Tuberculosis of the brain induces meningitis and hydrocephalus

(page 819).

Tuberculosis of the membranes of the spinal cord is seen alone

or in association with tuberculous inflammation of the brain.

Tuberculous disease of fascia is common; in fact, fascia is peculiarly prone to infection. Fascia may be attacked primarily, and when it is, the disease is apt to spread rapidly and widely and to produce most disastrous results. The elder Senn regards tuberculosis of the intermuscular septa of the thigh as a very grave condition, which, if extensive, demands amputation of the limb. Secondary tuberculosis of fascia is far more common than the primary form, the original focus of disease being in bone, joint, tendon-sheath, or lymph-gland.

Tuberculosis of muscle is rare. Instances of primary tuberculosis have been reported. Secondary tuberculosis is more common, but even this condition is rare, muscle seeming to have a high degree of resistance.

Tuberculous disease of bone (page 501) is very common in youth, and usually a sprain or a contusion, which is oftener slight than severe, precedes any signs of the disease. The injury establishes a point of least resistance, and in the damaged area the bacilli are deposited and multiply, or else a latent area of tuberculosis is roused into activity by the traumatism. The organisms may be deposited directly from the blood, or may arrive in an embolism from a distant tuberculous focus (lung or lymph-gland), which embolus is caught in a terminal artery in the end of a long bone and causes a wedge-shaped infarction.

Tuberculous osteomyelitis, as a rule, begins just beneath the articular cartilage or in the epiphysis. There may be one focus, several foci or many foci in the same bone. The products of the tuberculous inflammation constitute tuberculous nodules which destroy the medullary tissue and hence cut off the nutrition of adjacent bone. Bone trabeculæ are destroyed, and tuberculous granulations take their place, and here and there small dead portions of bone trabeculæ lie as sequestra among the granulations. In some bones, for instance, the vertebræ and the bones of the corpus and tarsus, the tuberculous process spreads widely; in some it tends to remain localized. Tuberculous granulations may be absorbed, may be encapsuled, may be replaced by fibrous tissue, or may caseate (page 230). When an osseous tuberculous focus spreads and finally reaches the surface of the bone the

stimulated periosteum produces new bone, while bone destruction is still going on within. Under such circumstances the bone enlarges and becomes spindle shaped, as is seen in a phalanx, the seat of tuberculous osteomyelitis, the condition known as spina ventrosa.

Tuberculous disease of the joints (page 500) is called "white redling" and also pulpy degeneration of the synovial membrane. Joints are especially liable to tuberculosis in youth, although the wrist and shoulder not intrequently suffer in adult life. Joint-tuberculosis is often preceded by an injury. The tuberculous process may begin in the synovial membrane. Primary synovial tuberculosis is most often met with in the knee-joint. Usually the disease begins in the head of a bone, dry caries resulting, necrosis ensuing, or an

abscess forming, which may break into the joint.

Tuberculosis of lymphatic glands is known as "tuberculous adenitis." It is the most typical lesion of scrofula. Tuberculous adenitis is most frequent between the third and fifteenth years. A person not of the tuberculous type may acquire tuberculosis of the glands, but the disease is unquestionably of much greater frequency in those who are recognized as predisposed to tuberculosis. Tuberculous glands may get well, may even calcify, but usually caseate if left alone. Long after healing they may break down and soften breidual abscess of Paget). They very frequently suppurate because of mixed infection. Though at first a local disease, tuberculous glands may prove to be a dangerous focus of infection, furnishing bacteria which are carried by blood or lymph to distant organs or throughout the entire system. Glandular enlargement is in rare instances widely diffused, but it is far more commonly localized. Enlargement of the cervical glands is most common. Tuberculous disease of the mesenteric gland is known as tabes mesenterica. Tuberculosis of lymphareds are the large beautiful as the larg

glands may be due either to bovine bacilli or to human bacilli.

Tuberculosis of the cervical lymph=glands is a very common condition. It is most common in young children and is quite often seen in young adults. It is rare in those of middle age. In the majority of cases infection takes place from the tonsils, pharynx, or posterior part of the oral cavity and in these cases the first glands to enlarge are those just below the parotid salivary gland. In a number of cases enlargement begins in the submaxillary or submental glands and in these cases infection originates from the teeth, mouth, orface (Dowd, in "Surgery, Gynecology, and Obstetrics," March 1909). A hiberculous lesion of the scalp may be followed by tuberculosis of the parotid mph-glands. Cervical adenitis may be unilateral or bilateral and is a very thronic condition. It is predisposed to by enlargement of the tonsils, adeholds, and nasopharyngeal catarrh. In 30 per cent. of cases the bacilli of bovine tuberculosis may be found (Dowd, Ibid.). The enlargements usually arise insidiously, but sometimes (after whooping-cough, measles, or scarlet lever) they come on more rapidly. When first observed the enlargements are mall, round, firm, isolated, painless and somewhat movable. As they enlarge they fuse into an irregular swelling which may be quite tender and is always anchored to surrounding parts. As the glands caseate the mass softens, the kin over it becomes adherent and red, and finally breaks open. Cold abscess may form or mixed infection with pus cocci may take place.

Cervical lymphadenitis may be confused with lymphadenoma. The former, as a rule, first appears in the submaxillary triangle; the latter, in the

occipital or sternomastoid glands. The former are more tender, softer, and less movable than the latter. Tuberculous glands weld together, they are apt to remain localized for a considerable time, and they tend to soften. They may be accompanied by other tuberculous manifestations. Lymphadenoma from the start affects many glands; it may arise simultaneously in several regions, although in some cases there is a distinct beginning in one region. Lymphadenoma shows very little tendency to suppurate, and does not break down except late in the course of the disease, and is accompanied by great debility and anemia. Tuberculin tests may aid in the diagnosis, but a difficulty is that Hodgkin's disease and tuberculosis may coexist. Malignant gland-tumors infiltrate adjacent glands and other structures, binding skin,

muscles, and glands into one hard, firm mass.

Tuberculous cervical adenitis is in most instances a reasonably curable condition. Some cases can be cured by open-air treatment, food, medicine, and hygienic care. In most, however, operation is indicated in addition to such treatment, and these operations are usually successful if thoroughly performed. When possible operation should be performed when the patient is at the seaside, or, at least, the patient should convalesce there if circumstances permit. Thorough extirpation is the proper operative treatment and any diseased condition of scalp, face, mouth, tonsil, or nasopharynx is to be corrected. My belief is that about 75 per cent. of cases are permanently cured by thorough operation. If a patient is well five years after operation the cure may be regarded as permanent. Cured cases seldom die subsequently of any tuberculous lesion.

It is not uncommon after removal of infected glands and healing of the wound to have several or numerous small hard nodules form beneath the skin in the area operated upon. Dowd extirpated some of these nodules and found they were not tuberculous, but were fibrous. I have been able to con-

firm Dowd's statement in several of my own patients.

Medical treatment is not nearly so valuable as surgical treatment in this form of tuberculosis. If medical treatment alone is relied on, many of these cases develop pulmonary tuberculosis. Attridge, quoting Demme and Dowd ("Surgery, Gynecology, and Obstetrics," Dec., 1908), sets the number which develop it when medical treatment is relied on at 21 per cent., and the number developing other distant tuberculous lesions at 8.2 per cent. A total of 20.2 per cent., and these figures do not include bone infections and late infections of the lymph-nodes. Even in cases supposed to have been cured by medical means it will be found that most of them react to tuberculin, showing that lesions are latent rather than cured. Wohlgemuth shows that complete removal cures 75 per cent. of cases; curetting and drainage cures 63 per cent.; general treatment, 24 per cent. (Attridge, Ibid.). In a series of 100 cases operated upon by Dowd, pulmonary tuberculosis arose in but I case and bone tuberculosis in 3 cases. If miliary tuberculosis exists, if the patient is much exhausted, if the infection is not definitely localized, or if an internal organ is the seat of active tuberculosis, operation is not indicated.

Death seldom follows operation. The mortality without operation is probably 10 per cent. Complete extirpation of the involved group of glands is practised when the disease is well localized. If it is not well localized I follow Attridge's plan (Ibid) and wait until it becomes so, treating the patient in the Rickets 255

interval by open-air life, nourishing food, medicine, and the x-rays. If softening occurs, the area should be incised and curetted and the exposed surface should be treated by repeated applications of tincture of iodin. When healing occurs, extirpation is to be performed. If sinus formation exists mixed infection has occurred or will occur and the sinuses must be curetted and treated with iodin until they heal, when the glands may be extirpated. I do not believe in a bilateral extirpation at one séance. The operation on one side only is prolonged and bloody and is all the patient is fit to stand. If both sides of the neck are involved an interval of several weeks should be insisted on before the other side is attacked.

In chronic cases of cervical lymphadenitis it is invariably necessary to search for intraoral or nasopharyngeal disease, and if such disease exists it must be treated before the glands are removed. After operation rigid open-air life is insisted on.

Tuberculosis of tendon-sheaths (tuberculous tenosynovitis) is discussed on page 736.

Tuberculosis of the Kidney .- (See page 1287.)

Tuberculosis may attack the Fallopian tubes, ovaries, or uterus. Tuberculosis of the urethra, prostate gland, seminal vesicles,

and bladder is considered in the section on Regional Surgery.

Tuberculosis of the Testicle (page 1389).—This disease is not rare. It is sometimes primary, but is usually preceded by tuberculosis of the kidney, bladder, or prostate. But one testicle is affected in the beginning, but the other gland is apt to be attacked later. The tuberculous mass softens, becomes adherent to the scrotum, and breaks or bursts, exposing the damaged testicle (jungus of the testicle). The cord is apt to be involved in tuberculosis of the testicle.

## XIV. RACHITIS, OR RICKETS.

Rickets is a chronic disorder of nutrition arising during the early years of life (the first two or three) as a result of insufficient or of improper diet, aided and abetted in many cases by bad hygienic surroundings. A deficiency of fat and phosphate in the food or the use of a diet which, by inducing gastrointestinal catarrh, prevents assimilation, causes rickets. It is characterized by incomplete osteogenesis and other nutritive failures. The disease is not common in nursing children unless breast-feeding has been unduly prolonged, and children fed upon artificial food are particularly apt to develop it. Holt says such diet is very deficient in fat and often in proteids, and contains an ctoss of carbohydrates ("Diseases of Infancy and Childhood"). J. Bland Sutton made some valuable experiments to indicate the injury done animals of denying them natural diet. He fed lion cubs in the London Zoological Garlens on raw horse meat only and the animals developed rickets. The fickety animals rapidly recovered on feeding them with milk and powdered bones mixed with cod-liver oil. The disease is essentially a city malady, "being principally seen in children living in crowded tenements where the effects of improper food are most strikingly shown; yet even here the disease Is tare in those who get a plentiful supply of good breast-milk" (Holt). Rickets must not be regarded as a bone disease. It is true the bones are affected, but so are various structures and organs, all of the disorders being due to an underlying nutritive defect. Some maintain that lactic acid, produced in the intestinal canal, causes bone inflammation, but most observers do not believe the bone changes are inflammatory. Children are very seldom born with rickets, but develop it later, the period of greatest liability being between the seventh month and the fifteenth month. So-called congenital rickets is usually sporadic cretinism. A child with rickets may become scorbutic (scurvy rickets). Some regard rickets as the result of an infection. Others think it results from thymus atrophy (Mendel).

Whatever may be the cause of rickets, the essential condition in the bones is an insufficient deposit of mineral matter in the new bone cells. The new bone is soft and vascular and bone lamellæ toward the medullary canal are actually absorbed. There is excessive proliferation of cartilage which results in enlargement. The proliferating and imperfectly ossified cells cause enlargements at the ends of long bones and at the sternal ends of the ribs and various bones bend and are distorted. The parietal bone bulges on each side, the fontanels remain long open; there may be unossified gaps in the occipital bone, membrane only filling them (craniotabes). There may be pigeon-breast, bent long bones, curved spine and distorted pelvis. The bones later may become firmly ossified in deformity. In rickets the spleen

and liver are enlarged and the thymus is atrophied.

Evidences of Rickets .- The condition is one of general ill-health; the child is ill-nourished, pallid, flabby; it has a tumid belly and suffers from attacks of diarrhea and sick stomach; it is disinclined for exertion and has a capricious appetite; it is liable to night-sweats; enlarged glands are often noted, the teeth appear behind time, and the fontanels close late. In health the posterior fontanel closes in the second month and the anterior fontanel in the eighteenth month. In rickets the anterior fontanel is often open when the child is three years of age. The sutures are often open at the end of the first year. The head is square in shape, the cranial bones are thick, and areas of thickening known as bosses appear over the parietal bones. The head is large and the forehead bulges. The long bones become much curved, the upper part of the chest sinks in, curvature of the spine appears, and the pelvis is distorted. The ligaments are relaxed and lengthened and the joints are wobbly. The muscles are feeble and ill-developed. Infantile convulsions are common. Nocturnal restlessness and night terrors are the rule. Laryngismus stridulus and tetany may occur. Swelling appears in the articular heads of long bones, by the side of the epiphyseal cartilages, and in the sternal ends of the ribs, forming in the latter case rachitic beads. The lesions of rickets are due to imperfect ossification of the animal matter which is prepared for bone-formation, and the soft bones gradually bend. The swellings at the articular heads are due to pressure forcing out the soft bone into rings. Rachitic children rarely grow to full size, and the disease is responsible for many dwarfs. Most cases recover without distinct deformity, but the time lost during the period when active development should have gone on cannot be made up, and some slight deficiency is sure to remain. Bowlegs, knock-knees, and spinal curvatures are usually rachitic in origin. The disease may be associated with scurvy, inherited syphilis, or tuberculosis. In appearance the rickety child is

pot-bellied, pale and anemic, and usually fat and flabby, though occasionally thin. There is great liability to enlargement of the tonsils, gastro-intestinal catarrh, and bronchial catarrh. The blood is deficient in red corpuscles and hemoglobin, and sometimes there is leukocytosis. The disease lasts for many months and is usually recovered from. It does not directly produce death, but is a powerful indirect cause of infant mortality because it lessens resistance and predisposes to many diseases. It is almost always afebrile; rarely congenital; and in unusual cases known as late rickets develops between the fifth and tenth year. The so-called acute rickets is practically always scurvy (Holt). The victims of rachitis are very liable to fracture the bones from slight force and green-stick fractures are particularly prone to occur. After fracture of a rickety bone union is usually delayed.

Treatment.—The treatment consists in having the child live as much as possible in the open air and sunshine. Salt-water baths are useful. Sea air s very beneficial. Fresh food (milk, cream, and meat-juice) should be ordered. Cod-liver oil, syrup of the iodid of iron, arsenic, and some form of phosphorus are to be administered. It is absolutely necessary to improve the primary assimilation. Slight deformities of the extremities require no special treatment unless they increase. If the deformity is marked or is increasing, use braces; employ massage, manipulation, and faradism. Holt points out that by the time the child is two years of age the bones are so firm that the pressure of a brace cannot cure the deformity. Hence after this age braces are useless. Pronounced established deformities of the extremities are usually treated surgically. Kyphosis is treated by making the patient lie upon a hard bed without a pillow. The child sits up a few hours each day, the shoulders being held back and support applied to the body. In bad cases, during the time the child is erect it should wear a brace or plaster-of-Paris jacket. Daily manipulation, the child lying prone, is helpful. Friction and electricity to the spinal muscles do good.

Scorbutus (Scurvy) .- This disease is rare to-day in adults, but was at one time very common among those who took long voyages, or who engaged in campaigns, or were the victims of sieges. Of recent years it is very uncommon, and has occurred chiefly among voyagers in the Arctic regions or those who were beleaguered. Some years ago I saw several cases in a large almshouse. It is important to remember that though scurvy is rare in adults, it is by no means uncommon in ill-nourished infants. (A most graphic picture of sturyy as it used to occur will be found in "A Voyage Around the World,"

by Lord Anson. Compiled by the Rev. R. Walter.)

Scurvy is a constitutional malady due to the consumption of improper diet, and especially to the employment of a diet characterized by the absence of

The use of salt meat as a staple article seems to favor the production of the disease. Garrod considered absence of potassium salt to be the real Absence of variety in diet, bad water, poorly ventilated quarters, and insufficient exercise favor the development of the disease. Some believe that an organic poison derived from tainted food is responsible (Torup). A bacterial origin has been suggested by Berthenson, Babés, and others. Certain studies made in the Transvaal suggest the bacterial origin of scurvy. Myer Coplans ("Lancet," June 18, 1904) states that it occurred

in those getting excellent rations and began as inflammation of the gums, the constitutional symptoms following. If the gum condition was early recognized and cured simply by cleanliness and antiseptics, that is, by pure local treatment, constitutional trouble did not develop.

Scurvy begins with weakness, drowsiness, muscular pains, and great susceptibility to cold. The skin is pallid or dirty white, and is occasionally mottled and often peels off. The patient is breathless on the slightest exertion. The pulse is excessively weak and slow. There is no fever. The gums may be tender and inflamed from the start, but in most cases they are not. After two or three weeks, usually the gums become tender, painful, and swollen, and bleed at frequent intervals; the breath becomes offensive, the teeth loosen and even drop out; subcutaneous hemorrhages take place, giving rise to petechiæ or extensive extravasations; the vision becomes dim; the



Fig. 98.—The gums in scurvy.

urine becomes scanty and of low specific gravity; cutaneous vesicles form, rupture, and give rise to bleeding ulcers, and ulcers likewise arise from breaking down of blood extravasations; hemorrhages take place into and between the muscles, and in severe cases beneath the periosteum and into joints, and blood may flow from the nose, lungs, kidneys, stomach, and intestines. Deep hemorrhages are felt as hard lumps. Bleeding at an epiphyseal line may separate the epiphysis from the shaft. If an inflammation or ulceration arises at any point, fever is observed. It was observed by DeHaven, who commanded the Grinell expedition in search of Sir John Franklin, that scurvy causes old and soundly healed wounds to ulcerate. The same observation was made years before in Lord Anson's voyage. A sailor of the "Centurion" had been wounded fifty years before at the battle of the Boyne. He developed scurvy and the old wound opened. Most cases of scurvy get well under proper treatment, but complete recovery is not attained for a long time. Sudden death is liable to occur if any exertion is made.

Captain Cook succeeded in preventing scurvy among his sailors by providing plenty of fresh water; guarding them against fatigue, wet, and extremes of heat and cold; attending to cleanliness and ventilation, and stimulating cheerfulness. This great navigator lost no men from scurvy. After the time of Captain Cook, the British Admiralty, acting on the suggestions of Lind and Blane, provided ships with lime-juice or lemon-juice with the most beneficial results in preventing the disease. Scurvy is prevented at the present time by employing a proper diet and by maintaining cleanliness and hygienic conditions.

The following agents are believed to be especially useful as preventatives: fresh meat, lemon-juice, cider, vinegar, milk, eggs, onions, cranberries, cabbages, pickles, potatoes, and lime-juice. When the disease develops, give vinegar, lemon-juice, onions, scraped apples, cider, nitrate of potassium, whiskey or brandy, and plenty of nourishing food. Antiseptic mouth-washes are necessary and strychnin is a valuable stimulant to the circulation. Sleep must be secured and ulcers are treated by antiseptic dressings and compression.

Infantile scurvy or Barlow's disease may exist alone or with rickets (scurvy rickets). It occurs most often in the children of the well-to-do, those who have been brought up on artificial foods. It occurs between the eighth and eighteenth months of life. The child is anemic, suffers from gastro-intestinal disorders, spongy and bleeding gums, weakness of the legs, general muscular tenderness, night-sweats, and often febrile attacks (Rotch), bleeding from the nose, bleeding beneath the skin (blue spots), bloody urine and stools, bleeding beneath the periosteum, into joints, viscera, or muscles. In some cases hematuria is the first and perhaps the only symptom (J. Lovett Morse, "Jour. Am. Med. Assoc.," Dec. 17, 1904). A subperiosteal hemorrhage is very dense, is tender, is fusiform in outline, and does not fluctuate. It is sometimes mistaken for sarcoma. In one case seen by the author a hemorrhage beneath the periosteum of the femur was mistaken for a sarcoma. The limb attacked is flexed, and the child will not move it. Separation of an epiphysis may result from hemorrhage between it and the bone. Infantile scurvy is often unrecognized. If promptly treated, recovery is the rule, otherwise death may occur from exhaustion.

Treatment.—Keep the child quiet in bed and give liberal amounts of cow's milk and beef-juice. Administer orange-juice, grape-juice, scraped apples, and tonics. To children over one year of age give potatoes. Antiseptic mouth-washes are necessary.

## XV. CONTUSIONS AND WOUNDS.

Contusions.—A contusion or bruise is a subcutaneous laceration, due to the application of blunt force, the skin above it being uninjured or damaged without a surface-breach and blood being effused. Punches, kicks, blows from a blackjack, etc., cause contusions. In intra-abdominal contusions the skin of the abdomen is frequently not damaged. In contusions of structures overlying a bone the skin suffers with the deeper structures. If a large vessel is ruptured, hemorrhage is profuse and much blood gathers in the

tissue. If only small vessels suffer, hemorrhage is moderate. An ecchymosis is diffuse hemorrhage over a large area, the blood lying in the spaces of the subcutaneous or submucous areolar tissue. A very small ecchymosis is known as a petechia; a very large ecchymosis is called a suffusion or extravasation. A hematoma is a blood-tumor or a circumscribed hemorrhage, the blood lying in a distinct cavity in the tissue. In extremely severe contusions tissue vitality may be destroyed or so seriously impaired that gangrene follows. Suppuration rarely occurs, but occasionally does so, and is most apt to in a drunkard or a person of dilapidated constitution. When hemorrhage arises in the tissues after a contusing force it soon ceases unless a very considerable vessel is ruptured. The arrest of hemorrhage is brought about by the resistance of the tissues, the contraction and retraction of the vessels, coagulation of blood, and in some cases of severe injury coagulation is favored by syncope. Blood in the tissues, as a rule, soon coagulates, the fluid elements being absorbed and the red corpuscles breaking up and setting free pigment, which pigment may be carried away from the seat of injury or may crystallize and remain there as hematoidin. In some cases inflammation occurs about the extravasated blood, a capsule of fibrous tissue being formed, and the blood being slowly absorbed, or the fluid elements remaining unabsorbed (blood-cyst), or the blood becoming thicker and thicker, finally calcifying. Blood in serous sacs (joints, pleura, pericardium) coagulates very slowly. As blood is being absorbed it undergoes chemical changes and color-changes ensue, the part being at first red and then becoming purple, black, green, lemon, and citron. The stain following a contusion is most marked in the most dependent area. After a bruise of the periosteum a blood-clot forms, much tissue-induration occurs, and a hard edge can be detected by palpation at the margin of the clot.

Symptoms.—The symptoms are tenderness, swelling, and numbness followed by some aching pain or a feeling of soreness. The pain rarely persists beyond the first twenty-four hours. Cutaneous discoloration appears quickly in superficial contusions, but only after days in deep ones. In some regions—the scalp, for instance—it can scarcely be detected; in others, as in the eyelid and vulva, discoloration is early, widespread, and marked. Discoloration and swelling are very marked in regions where loose cellular tissue abounds (eyelids, prepuce, scrotum). The discoloration is at first red, and becomes successively purple, black, green, lemon, and citron. The swelling is primarily due to blood, and is added to by inflammatory exudation. In a more severe contusion a hematoma may form. A recent hematoma fluctuates, but gradually, because of cell-proliferation, the edge becomes hard and the center continues to fluctuate. The mass gradually grows smaller and finally disappears. A subperiosteal hematoma of the scalp may be mistaken for depressed fracture of the skull. Any form of hematoma of the scalp may be mistaken for an abscess, but differs from it in the absence of inflammatory signs. It occasionally, though rarely, suppurates. In a case in which suppuration occurs an abrasion, which may be very minute, often exists on the skin. In any severe contusion there is considerable and possibly grave, or even fatal, shock.

Treatment.—In a severe injury bring about reaction from the shock. Local treatment consists in rest, elevation, and compression to arrest bleeding, antagonize inflammation, and control swelling. Cold is useful early in most Shock 261

cases, but it is not suited to very severe contusions nor to contusions in the debilitated or aged, as in such cases it may cause gangrene. In very severe confusions employ heat and stimulation. When inflammation is subsiding after a contusion, compression and inunctions of ichthyol should be employed. Massage and passive motion are imperatively needed after contusion of a joint. If the amount of blood is very large, massage must not be used because it may cause embolism or fat-embolism. If a distinct cavity exists, aspiration or incision lessens the danger of fat-embolism. A contusion should never be incised unless the amount of blood is large and a distinct cavity exists, or hemorrhage continues, or infection takes place, or a lump remains for some weeks, or gangrene is threatened. For persistent bleeding freely lay open the contused area, turn out clots, ligate vessels, insert drainagestrands or a tube, and close the wound. If gangrene is feared, make incisions and apply heat to the part. If a slough forms, employ antiseptic fomentations. The constitutional treatment for contusion, after the patient has reacted from shock, is the same as that for inflammation. (See Abdomen, etc.)

Wounds.—A wound is a breach of surface continuity effected by a sudden mechanical force. Wounds are divided into open and subcutaneous, septic and aseptic, incised, contused, lacerated, punctured, gunshot, stab, and

poisoned wounds.

The local phenomena of wounds are pain, hemorrhage, loss of func-

tion, and gaping or retraction of edges.

Pain is due to the injury of nerves, and it varies according to the situation and the nature of the injury. It is influenced by temperament, excitement, and preoccupation. It may not be felt at all at the time of the injury. At first it is usually acute, becoming later dull and aching. In an aseptic wound the pain usually remains slight, but in an infected wound it always becomes severe.

The nature and amount of hemorrhage vary with the state of the system, the vascularity of the part, and the variety of injury.

Loss of function depends on the situation and extent of the injury.

Gaping or retraction of edges is due to tissue-elasticity, and varies according to the tissues injured and the direction, nature, and extent of the wound.

The constitutional condition after a severe injury is a state known as shock.

Shock.—The name shock was introduced in 1705 by James Latta to designate the condition ensuing upon severe injury. (See G. C. Kinnaman, in "Annals of Surg.," Dec., 1903.) Shock is a depression of the vital powers arising from an injury or a profound emotion acting on the nerve-centers and inducing exhaustion or inhibition of the vasomotor mechanism. Exhaustion is gradually induced; inhibition is suddenly produced. By overstimulation of sensory nerves violent impressions are conveyed to the nerve-centers, the vasomotor center is exhausted or inhibited, vasoconstrictor power is lost, the arteries and capillaries are depleted or nearly emptied of blood, and the blood is largely transferred to the veins. The blood-pressure is lowered, the cardiac action is impaired, the respiratory action is impeded, and quantities of dark-colored blood gather in the somatic veins, but especially in the veins of the splanchnic area. (See the masterly study of "Surgical Shock" by Crile.) In shock the abdominal veins are greatly distended

and the other veins of the body may also be overfull, the arteries contain less blood than normal, and an insufficient amount of blood is sent to the heart and to the vital centers in the brain. In other words, in shock there is a deficiency in the circulating blood. The term collapse is used by some to designate a severe condition of shock, and is employed by others as a name for a condition produced by functional depression of the vasomotor center the result of mental disturbance, cardiac failure, respiratory failure, or vasomotor insufficiency, rather than of physical injury. Crile regards collapse as inhibition of the vasomotor center, in contrast to shock, which is exhaustion of the center. As a matter of fact, shock and collapse are often both present. That the bombardment of the nerve-centers by a tumult of peripheral impressions causes shock is shown by the fact that if the nerves from a part are thoroughly cocainized so that they will not transmit sensation, operation upon the part produces practically no shock. Crile calls such cocainization the introduction of a physiological block. Shock may be slight and transient, it may be severe and prolonged, it is usually sudden in onset, but may come on gradually, and it may even produce almost instant death. I agree with Bloodgood that even a violent injury does not of necessity at once produce it. Every now and then we see a man with a crushed limb who does not exhibit shock, the condition gradually coming on from pain, hemorrhage, terror, etc. During an operation if shock arises it is apt to do so gradually, but this is not always the case, for sometimes it comes on with great suddenness, for instance, when traction is made upon the pedicle of the spleen, when the bone of the thigh is sawed through, or when there is a burst of blood from a large vessel. Sudden death from shock is due to reflex stimulation of the pneumogastric nuclei and arrest of cardiac action. It is known as death by inhibition. Shock is more severe in women than in men, in the nervous and sanguine than in the lymphatic, in those weakened by suffering than in those who are strangers to illness. It is predisposed to by fear, by disease of the kidneys, diabetes, chronic cardiac disease, and alcoholism. Injuries of nerves, of brain, of the intrathoracic viscera, of the intra-abdominal viscera, of the urethra, or of the testicle produce extreme shock. Anything which extracts the body-heat favors the development of shock (exposure to cold air, insufficient covering, chilling the body by solutions or wet towels). Cerebral concussion is shock plus other conditions. Sudden and profuse hemorrhage causes shock; so does prolonged anesthetization. Great shock may occur after the removal of a large tumor or a quantity of fluid from the abdomen. In such a case shock is brought about by the sudden removal of pressure and the consequent rapid distention of intra-abdominal veins. Exposure of tissue and vital parts to air aggra-

Symptoms.—The symptoms of ordinary shock (torpid or apathetic shock) are subnormal temperature; irregular, weak, rapid, and compressible pulse; cold, pallid, clammy, or profusely perspiring skin; shallow, irregular, and often gasping respiration. Consciousness is usually maintained, but there is an absence of mental originating power, the injured person answering when spoken to, but volunteering no statements and lying with partly closed lids and expressionless countenance in any position in which he may be placed. The answers to questions though apparently intelligent are utterly unreliable. There is great motor weakness. The pupils are dilated and react but slowly to light.

The sphincters are relaxed. Pain is slightly or not at all appreciated. Nausea is absent and vomiting may, as in concussion, presage reaction. Gastric regurgitation, after a considerable duration of shock, is not unusual, and is a had omen. Shock is not rarely followed by suppression of urine. Whereas the victim of shock is usually stupid and indifferent, he may become delirious. If delirium arises, the condition is very grave. Travers called shock with delinium erethistic or delirious shock. As a matter of fact, such a state is not genuine shock, but is either a traumatic or a toxic delirium. It is usually due to uremia or sepsis. Delirious shock is seen after a person has been bitten by a poisonous snake. Many years ago Travers described a secondary or delayed form of shock, which comes on several hours after an injury or violent emotional disturbance. This form of shock is seen not unusually in those who have passed through a railroad accident. It may be a sign of hemorrhage, and is sometimes met with after the administration of ether or chloroform. The statements made by a person who has recovered from a severe shock are always unreliable as to events which occurred while shock existed, and are often doubtful as to the details of the accident. Not unusually the memory of the accident is perverted or even destroyed.

Diagnosis.—Concealed hemorrhage is difficult to differentiate from shock. It produces impairment of vision (retinal anemia), irregular tossing, frequent yawning, great thirst, nausea, and sometimes convulsions. In shock the hemoglobin is unaltered; in hemorrhage it is enormously reduced (Hare and Martin). In hemorrhage recurrent attacks of syncope are met with. In pure shock such attacks do not occur. In concealed hemorrhage the abdomen may exhibit physical signs of a rapidly increasing collection of fluid. Shock and hemorrhage are often associated. The essential characteristic of shock is rapid onset, which separates it distinctly from exhaustion. It arises at a

much earlier period after an injury than does fat-embolism.

The Prevention of Shock in Operations.—Examine the patient with care before operating, giving special attention to the condition of the kidneys. The amount of urine passed and the amount of urea it contains should always be determined when possible. The amount of urea should be estimated from the twenty-four hours' urine. The normal amount of urine in the twentyfour hours is about fifty ounces and the normal amount of urea 2 per cent. Less urea is significant of danger from shock and subsequent kidney complications. If the condition of the patient leads us to fear that there will be dangerous shock, do not purge him severely before operation, and just previous to operation give a rectal injection of hot saline fluid and a hypodermatic injection of 100 of a grain of atropin. It is also a good plan in some cases to give a hypodermatic injection of gr. \(\frac{1}{2}\) of morphin twenty minutes before operation. It tranquillizes the patient and less ether will be needed to anesthetize him. Examine the patient thoroughly and prepare him carefully beforehand and decide if he should take a general anesthetic at all, and, if so which one. In some cases a local anesthetic should be used, for instance, some cases of typhoid perforation and strangulated hernia.

Occasionally the nerves from the damaged part should be infiltrated with cocain (Crile). This prevents the ascent of peripheral impressions, makes what Crile calls a "physiological block," and so prevents shock. After this infiltration a limb can be amputated below the infiltrated area without pain

and without depression of the vital powers. In some few cases in which we fear shock spinal anesthesia is used; in others scopolamin and morphia. If a general anesthetic is used it must be skillfully given and not a drop is given beyond the amount necessary to maintain thorough anesthesia. Cover every part but the field of operation with hot blankets and put cans of hot water about the patient, or put him on a bed composed of hot-water pipes covered with blankets. Prevent bleeding with the greatest possible care. Operate as rapidly as is consistent with safety and thoroughness. If shock develops during an operation hasten on the work, lessen the amount of ether, and apply active treatment. Return the patient to bed as soon as possible and without exposure in cold halls or a windy elevation. Occasionally it becomes necessary to suspend an operation in order to prevent death on the table.

Treatment.—In treating ordinary apathetic shock raise the feet and lower the head, unless this position causes cyanosis. At least place the head flat and the body recumbent. Wrap the patient in hot blankets and surround him with hot bottles, hot bricks, hot-water bags, or cans of hot water. Always wrap a can, a bottle, or a bag in flannel, to avoid burning the patient. Ordinary stimulants seem of but little value and drugs given by the stomach are not absorbed. Salt solution may be thrown into a vein (intravenous infusion), may be given by the rectum (enteroclysis), or subcutaneously (hypodermoclysis). Intravenous infusion does good, but, unfortunately, the benefit is very temporary except in cases associated with hemorrhage. In hemorrhage it should always be given, and it should be given mixed with adrenalin chlorid (1 teaspoonful of the 1: 1000 solution of adrenalin chlorid is added to 1 liter of salt solution). The operation of intravenous infusion is described on page 465. The custom of giving salt solution in a vein has become so common that resident physicians are apt to resort to it as a routine. It is to be remembered that if given rapidly or in too great quantity it may gather in the chambers of a dilated right heart and arrest a heart so weakened that it has almost reached its limit of function. I am satisfied that the rapid administration of salt solution intravenously is responsible for some deaths. Crile maintains that the only way "to increase and sustain the blood-pressure when the vasomotor center is exhausted" is to "create a peripheral resistance either by a drug acting on the blood-vessels themselves or by mechanical pressure."\* In order to accomplish this he used adrenalin chlorid. Because of the rapidity with which this drug is oxidized he gives it intravenously, slowly and continuously from a buret, using a solution of a strength of from 1 in 50,000 to 1 in 100,000 in salt solution. The rate of flow should be "controlled by a screw-cock attached to the rubber tube." Crile also places the patient in a rubber suit and distends the suit by means of an air pump and thus obtains equable pressure upon the cutaneous surface and an increase of peripheral vascular resistance. The difficulty with giving the solution in a vein is, the drug first comes in contact with "the vessels having the least power of influencing blood-pressure," and before a notable rise can be affected by arterial action "it is necessary that the solution should pass through the right heart, the lungs on its way to the aorta, then finally affecting the coronary arteries" (Crile, in "Am. Jour.

<sup>\*</sup>George Crile, in Boston Med. and Surg. Jour., March 5, 1903.

Med. Sciences," Jan., 1909). The best way to use adrenalin solution in severe shock is to introduce it as Crile now advises, that is, into the arterial system and toward the heart. Occasionally, by this means, resuscitation from apparent death may be accomplished. Crile calls this method centripetal arterial transfusion. It is applied as follows ("Am. Jour. Med. Sciences," April, 1909):

"In human resuscitation the technic is as follows: The patient in the prone posture is subjected at once to rapid rhythmic pressure upon the chest, with one hand on each side of the sternum. This pressure produces artificial respiration and a moderate artificial circulation. A cannula is inserted toward the heart into an artery. Normal saline, Ringer's, or Locke's solution, or, in their absence, sterile water, or, in extremity, even tap water, is infused by means of a funnel and rubber tubing. But as soon as the flow has begun the rubber tubing near the cannula is pierced with the needle of a hypodermic syringe loaded with 1: 1000 adrenalin chlorid and 15 to 30 minims are at once injected. Repeat the injection in a minute if needed. Synchronously with the injection of the adrenalin the rhythmic pressure upon the thorax is brought to a maximum. The resulting artificial circulation distributes the adrenalin that spreads its stimulating contact with the arteries, bringing a wave of powerful contractions and producing a rising arterial, hence coronary, pressure. When the coronary pressure rises to, say, 40 mm. or more, the heart is likely to spring into action. The first result of such action is to spread still further the blood-pressure-raising adrenalin, causing a further and vigorous rise in bloodpressure, possibly even doubling the normal. The excessively high pressure is most favorable to the resuscitation of tissue, especially of the central nervous system (Stewart). Just as soon as the heart-beat is established the cannula should be withdrawn, first, because it is no longer needed, and second, because the rising blood-pressure will drive a torrent of blood into the tube and funnel. Unless there has been hemorrhage, the only object in the use of saline infusion is to serve as a means of introducing the adrenalin into the arterial circulation toward the heart. Bandaging the extremities and abdomen tightly over masses of cotton is very useful."

In prolonged shock direct transfusion of blood should be employed (page 463). The use of hot and stimulating rectal enemata is important. The rectum may absorb fluids when the stomach refuses to do so. Enemata of hot normal salt solution are beneficial (enteroclysis). The tube is carried to the sigmoid flexure and the injection is introduced so as to distend the colon. Hypodermoclysis is given as follows: Insert an aspirator tube into the cellular tissue of the loin, scapular region, or under the mamma, cleansing the part first. The tube is attached to a fountain syringe, which is filled with normal salt solution, and is hung at a height of two or three feet above the bed (Fig. 99). In an hour's time a pint or more of fluid will enter the tissue and be absorbed. It is the custom to give hypodermatic injections of ether, brandy, strychnin, digitalis or atropin, or inhalations of amyl nitrite. Crile has demonstrated experimentally that strychnin is perfectly futile in pure shock and may actually aggravate the condition. In collapse it is of some value. We believe this statement is true clinically. Strychnin goads a heart to increased action when that organ has not sufficient blood passing into it to enable it to firmly and strongly contract; the use of strychnin in shock has been compared by Hare to beating a dying horse to make it pull. I believe that atropin is of

great benefit in shock, especially if the skin is very moist. This drug, according to my colleague, Prof. Hobart A. Hare, is a sedative to the vagus; but makes it particularly valuable is that it acts upon the vasomotor syncombats the dilatation of the blood-vessels, maintains vascular tone, pre stagnation of blood in any vessels, and increases the amount of moving b If the skin is very moist, atropin is particularly indicated. Senn recommentation that the hypodermatic injection of sterile camphorated oil, a syringeful efficient minutes, until reaction begins. Inhalation of oxygen is often of the



Fig. 99.—Subcutaneous saline infusion (Senn).

service, and artificial respiration may be necessary. Opiates are consindicated in shock. Mustard plasters should be placed over the heart, spand shins. A turpentine enema is useful. An enema of hot coffee whisky is valuable. In severe cases of shock, bandage the extremi Bandaging for the relief of shock is called *autotransfusion*. This proces increases peripheral resistance and enables the body to utilize to the advantage the small amount of circulating blood, and sends most of it to brain, where it will maintain the activity of the vital centers and keep up culation and respiration. For this purpose ordinary muslin bandages be used, or gauze bandages, or the bandages of Esmarch. Crile's rul suit accomplishes the object more satisfactorily than does bandaging

extremities. Abdominal massage helps drive out the imprisoned blood, and after massage sets free the abdominal blood apply a compress and binder. In serious cases artificial respiration and stimulation of the diaphragm with a galvanic current may be used. If shock comes on during an operation, the operation must be hurried or even abandoned, and proper treatment must be instituted at once. The anesthetist should give very little ether when shock becomes at all evident. Should we operate during shock? We should only do so when death without instant operation is inevitable. We must operate, if it is necessary to do so, to arrest hemorrhage, to relieve strangulated hernia, intestinal obstruction, obstruction of the air-passages, compound fractures of the skull, extravasated urine, or intraperitoneal extravasations from ruptured viscera. If hemorrhage can be temporarily controlled by pressure or a clamp, so much the better, and the permanent arrest can be effected after the reaction from shock. It is not wise, in the author's opinion, to amputate during shock. A tourniquet or Esmarch bandage should be applied, and attempts be made to bring about reaction, and when reaction is obtained the amputation should be performed. It is only just to say that some eminent surgeons oppose this rule. Roswell Park says that "shock is often alleviated by the prompt removal of mutilated limbs which, when still adherent to the trunk, seem to perpetuate the condition." The same leacher believes in operating at once upon severe compound fractures.\* After every operation keep careful watch upon the amount of urine passed, see to it that the patient takes sufficient fluid, and if the urine becomes scanty put a hot-water bag over the kidneys, give diuretics by the mouth, secure cutaneous activity, give saline purgatives, and administer hot saline enemata, If the condition is not soon benefited, the custom is to infuse hot saline fluid into a vein. I am doubtful if intravenous infusion of saline fluid is beneficial in suppression, and I even fear it may do harm (see the studies of Widal, Marie and Crouzon, Merklen, and others). In urinary suppression following accident or surgical operation (post-operative suppression or anuria) the condition is so dreadfully grave that it is justifiable to expose each kidney and split the capsule in order to relieve tension and in the hope of thus abating congestion. Post-operative suppression of urine is almost invariably fatal. Rössle ("Centralb. f. Chir.," 1907, xxxiv.) says that in certain cardiac and renal conditions salt solution damages the capillaries and does actual harm. Delayed shock is treated in the same manner as apathetic shock if hemorrhage can be excluded. If hemorrhage is the cause, the bleeding must be arrested, and blood be transfused, or saline fluid be infused into a vein. If delirious shock is due to sepsis, the treatment is that of sepsis. If it is a nervous delirium, give morphin and other sedatives. If due to uremia, the treatment is obvious.

Fat-embolism.—(See page 205.) Fever.—(See Fevers, page 133.)

Treatment of Wounds.—All wounds, other than those made by the surgeon, are regarded as infected. The rules for treating such wounds are:
(1) arrest hemorrhage; (2) bring about reaction; (3) remove foreign bodies;
(4) asepticize; (5) drain, coaptate the edges, and dress; and (6) secure rest to the part and combat overaction of the tissues. Constitutionally, allay pain, secure sleep, maintain the nutrition, and treat inflammatory conditions.

<sup>\*</sup>Park's "Surgery by American Authors."

Arrest of Hemorrhage.—To arrest hemorrhage the bleeding point must be controlled by an Esmarch band or digital pressure until ready to be grasped with forceps; it is then caught up and tied with catgut or aseptic silk. Slight hemorrhage ceases spontaneously on exposure of the bleeding point to air, and moderate hemorrhage ceases permanently after the temporary application of a clamp. An injured vessel when not of the smallest size must be ligated, even if it has ceased to bleed. Capillary oozing is checked by hot water and compression. If a large artery is divided in a limb, apply a tourniquet before ligating (see Wounds of Vessels).

Bringing about of Reaction .- (See Shock.)

Removal of Foreign Bodies.—Remove all foreign bodies visible to the eye (splinters, bits of glass, portions of clothing, gun-wadding, grains of dirt, etc.) with forceps and a stream of corrosive sublimate solution, sterile water, or normal salt solution. In a lacerated or contused wound portions of tissue injured beyond repair should be regarded as foreign bodies and be removed with scissors.

Cleaning the Wound.—To clean the wound shave the surrounding area, if it is hairy; scrub the surface about the wound with ethereal soap, green soap, or castile soap, wash with water, scrub with alcohol, and then with corrosive sublimate solution (1:1000). An accidental wound is infected, and must be well washed out with an antiseptic solution. In every wound in which we have reason to suspect tetanus infection a preventive dose of antitoxin should be given. We have particular occasion to apprehend tetanus if the wound is contaminated with feces, street dirt, stable dust, or stable refuse, or if it was infected with a toy pistol such as boys use to celebrate the Fourth of July. A clean wound made by the surgeon need not be irrigated; in fact, irrigation with an antiseptic fluid leads to necrosis of tissue, causes a profuse flow of serum, and necessitates drainage. If clots have gathered in a wound, they must be removed, as their presence will prevent accurate coaptation of the edges. In an infected wound they are washed out with a stream of corrosive sublimate solution. In a clean wound they are washed out with hot salt solution. If dirt is ground into a wound, as is often seen in crushes, pour sweet oil into the wound, rub it into the tissues, and scrub the wound with ethereal soap. The oil entangles the dirt, and the soap and water remove both oil and dirt. After the rough cleansing irrigate with corrosive sublimate solution. In some cases, especially in bone-injuries, it is necessary to scrape the wound with a curet. If a fissure of the skull is infected, enlarge the fissure with a chisel in order to clean it. In a badly infected wound one of the most valuable agents for use in producing disinfection is pure carbolic acid. After cleaning the wound, it is necessary in certain regions to examine in order to determine if tendons or considerable nerves have been cut. If such structures have been divided, they must be sutured with fine silk, chromic gut, or kangaroo-tendon.

Drainage, Closure, and Dressing.—Superficial wounds require no special drainage, as some wound-fluid will find exit between the stitches and the rest will be absorbed. A large or deep wound requires free drainage for at least twenty-four hours by means of a tube, strands of horsehair, silk, or catgut, or bits of iodoform gauze. An infected wound must invariably be drained. Good drainage may, to a considerable extent, compensate for imperfect anti-

sepsis. If capillary drains be employed, apply a moist dressing. Approximate the edges with interrupted sutures of silk or silkworm-gut if the wound is deep and considerable tension is inevitable. Catgut is used for superficial wounds and for those where tension is slight. If there is decided tension, silver wire may be used. In very deep wounds buried sutures must be used. These sutures may consist of absorbable material (kangaroo-tendon or catgut) or unabsorbable material (silver wire) or very fine silk. Of late I have been following the Johns Hopkins custom and have closed all clean wounds with sutures of very fine iron dved silk passed by small and very sharp sewing needles. By the use of these fine sutures a minimum amount of tissue necrosis occurs, the risk of infection is greatly lessened, and the resulting scar is the smallest that can be obtained. As is well known, tight sutures cause tissue necrosis and hence predispose to infection. It is impossible to tie the fine black silk very tight, because if we do so it breaks. It requires considerable practice to learn to tie the sutures without breaking. This fine silk can be buried without fear, as it never causes a sinus, and it is used for layer sutures with perfect confidence. I learned this plan from Dr. Harvey Cushing, and am much pleased with it. If the wound is infected, dress with warm, moist antiseptic gauze. If it is not infected, dress with dry sterile gauze. The custom once was to cover even dry gauze with a rubber dam to diffuse the fluids, but we now prefer to omit the rubber dam and use plentiful dressings. A dry dressing absorbs wound fluids quickly and is less likely to become infected, Change the dressings in twenty-four hours or sooner if they become soaked with discharge. Dressings are changed for cause, but not according to scheduled time. They must, of course, be changed when they become soaked with wound-fluid, and soaking may occur in a few hours, but may not occur for days. As long as the temperature remains normal, and the wound free from pain, if the dressing is not wet with discharge, it can be left in place unless removal is necessary to take out a drainage-tube. If pus forms, open the wound at once. Many surgeons sprinkle wounds before approximation and wound surfaces after approximation with a drying-powder. These powders are of great use in infected wounds, but are not necessary in clean wounds. Among the substances employed are salicylic acid, boric acid, calomel, acetanilid, aristol, iodoform, subiodid of bismuth, and glutol. In large wounds which cannot be approximated it is occasionally advisable to skin-graft by Thiersch's method. A small wound which cannot be sutured is dusted with an antiseptic powder and dressed. A granulating wound is dressed as is a healing ulcer. In recent infected wounds rest associated with Bier's treatment comprise the means of local treatment. Incision is usually required. In later infections or severe infections the wound must be opened widely and drained. A sloughing wound is opened, is dusted with iodoform or acetanilid, and is dressed with hot antiseptic fomentations.

Rest.—Severe wounds require the confinement of the patient to bed. Bandages, splints, etc., are used to secure rest. In a closed wound rest need not be protracted, in fact, our former custom was to insist upon it for too long a period. The slight irritation of moderate motion stimulates repair. We no longer feel it necessary to keep laparotomy cases in bed for three full weeks, but we get them up in from seven to ten days. By doing this we secure just as firm a cicatrix, greatly lessen the annoyance from constipation and flatulence,

and diminish notably the number of cases of post-operative pneumonia and phlebitis. I do not, however, advocate getting such patients up in twenty-four to thirty-six hours, as is advised by some surgeons. A patient with an infected wound or an open drainage wound should be confined to bed. The methods of combating inflammation have previously been set forth.

Constitutional Treatment.—Bring about reaction from depression, but prevent undue reaction. Feed the patient well, stimulate him if necessary, attend to the bowels and bladder, secure sleep, and allay pain. Watch for

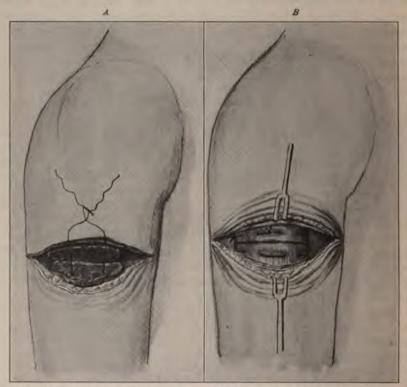


Fig. 100.—Muscle suture: A, Transverse wound of biceps muscle, showing marked retraction of muscle-ends and mattress suture in place; B, muscle suture completed (Senn).

complications, namely, inflammation, suppuration, gangrene, tetanus, erysipelas, suppression of urine, and pneumonia. Observe the temperature closely; it may be a danger-signal of urgent importance.

Incised Wounds.—An incised wound is a clean *cut* inflicted by an edged instrument. Only a thin film of tissue is so devitalized that it must die. These wounds have the best possible chance of union by first intention.

The pain may be very severe; but if the instrument is sharp and used quickly it may be trivial. The pain is less severe than that caused by some other varieties of wounds. The acute pain does not last long, and is followed by smarting. The hemorrhage is profuse, varying, of course, with the region cut. Bleeding from the scalp is violent, because there are numerous vessels

which lie in fibrous tissue and cannot retract nor contract. The edges of incised wounds retract because of tissue-elastricity, and the wound "gapes." If the skin or fasciæ are divided at a right angle to the muscle beneath, there is wide gaping. If the cut is parallel to the muscle-fibers, the gaping is slight.

When the skin is violently pulled upon, it tends to split in a certain line. Langer and Kocher speak of this as the line of cleavage, and point out the direction of these lines in various situations. A cut across the line of cleavage is followed by wide gaping. A cut in the direction of the line of cleavage produces slight gaping, and is followed by a trivial scar.

When a muscle is cut across, the wound edges widely separate. When a tendon is completely cut across, extensive separation occurs.

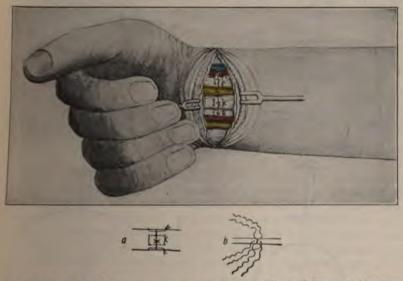


Fig. 101.—Suturing of tendons and nerves in incised wounds: a, Primary tendon suture; b, primary nerve suture (Senn).

An incised wound can be thoroughly inspected, all divided structures can be identified, foreign bodies can be easily removed, and disinfection can be satisfactorily carried out.

Treatment.—According to general principles. Arrest hemorrhage, asepticize, etc.

Examine the wound carefully to see if a nerve, a tendon, or a muscle is divided, and if such injury is discovered, suture at once (Figs. 100 and 101). If the wound is extensive or deep, it may be necessary to use buried sutures in order to keep the sides of the wound in contact. If the surface of a wound is approximated, but the depths are not, the dead space or cavity becomes filled with fluid, and infection almost certainly occurs. If buried sutures have not been used, such a cavity must be obliterated by the judicious application of pressure upon the surface. This is secured by the adaptation of a mass of loose or fluffed-up gauze, and the firm application of a bandage or binder. An

incised wound is usually closed with interrupted sutures (Figs. 102 and In adjusting the sutures, see that the edges of the wound are not inverted.

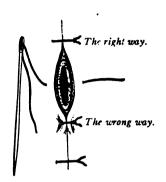


Fig. 102. — The interrupted suture (after Bryant)



Fig. 103.—Tying an interrupted The knot is placed to the *side* of the as shown in Fig. 102.



Fig. 104.—Continuous sutur

rests to the side of it. Tie the stitches firmly but not tightly. If a stitch too tightly it will make a furrow, as shown in Fig. 102, and undue tight

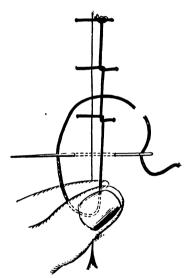


Fig. 105.—Ford's suture: a square knot, a single knot, a double or friction knot, and the first method of passing the needle to tie a single knot immediately.

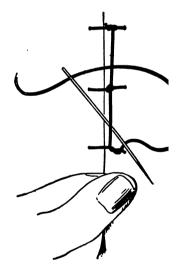


Fig. 106.—Ford's suture: showi square knots, a single knot, and the of completing a square knot.

sure to cause necrosis, and is often productive of a stitch-abscess. A viously stated, I usually close wounds with sutures of very fine black

This will break if we try to tie it tightly and as it never causes a sinus when retained in the tissues it can be used for buried sutures as well as for the skin. A silk suture and catgut suture should be tied with the reef knot; a suture of silkworm-gut may be tied with either a surgeon's knot or a reef knot. If a wound is on the face, particular care must be employed in closing it, in order to limit the amount of disfigurement. Fine silk sutures are passed with a small sharp needle or a subarticular stitch is used. In a clean wound stitches can, as a rule, be removed in from six to eight days. In a large wound one-half the stitches are removed at one sitting, and in a day or two the rest are removed. Stitches are promptly removed if they begin to cut out or if infection occurs.

The old continued suture is rarely used for skin-wounds at the present time. This suture is employed to suture the dura after division, to suture

the two layers of pleura together before an abscess of the lung is opened, to suture the peritoneum after laparotomy, and to suture the mucous membrane after cermin operations upon the stomach. The continued suture is shown in Fig. 104. A continuous suture knotted after each emergence was devised by Ford. It is very useful

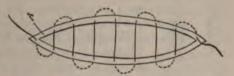


Fig. 107.—Halsted's subcuticular suture: A is the true skin.

devised by Ford. It is very useful in suturing the parietal peritoneum (Figs. 105 and 106).

Halsted's subcuticular stitch (Fig. 107) makes a most perfect closure of the skin-wound, and is followed by the smallest possible scar. In closing a deep wound the muscles and fasciæ are sutured in layers by buried sutures before the subcuticular stitch is inserted. It is only used in wounds which are almost certainly clean, as those made by the surgeon, and in wounds which do not require drainage. The suture material should be of silver wire caught upon a curved Hagedorn needle or silkworm-gut carried by a long, straight, round

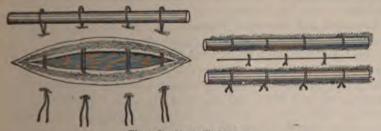


Fig. 108.-The quilled suture.

needle. The suture is passed through the corium on each side of the wound, as shown in Fig. 107. The curved needle must be held in the bite of a needle-holder. When the suture has been passed the ends are pulled upon, and the skin-wound closes neatly.

Halsted's suture does not penetrate the cuticle; hence, in passing it the white staphylococcus is not carried through stitch-holes and into the wound, an accident which might be followed by infection of a stitch-hole or even of

the wound. When it is desired to withdraw this suture, take one end in the bite of the forceps, cut it off short with scissors, catch the free end with forceps, and pull steadily upon it.

In very deep wounds or wounds in which there is much tension after

approximation the quilled suture (Fig. 108) or the button suture (Fig. 100) may be used. The twisted suture or hare-lip suture is shown in Fig. 110.

Problems of drainage, dressing, etc., are discussed on pages

76, 77, and 78.

If infection occurs, the wound becomes swollen, tender, painful, and discolored, and the temperature of the patient soon becomes elevated. In such a condition cut the stitches, disinfect, and drain.

Wounds of Mucous Membranes.—If the surgeon intends to inflict a wound upon a mu-



Fig. 110 .- The twisted suture,

Fig. 100.-Button cous surface, he should see to it that the patient's general suture.

condition is good. Thorough asepsis is impossible, and a good result depends largely upon the vital resistance of the tissues. Before operating, irrigate the part frequently with boric acid, peroxid of hydrogen, or normal salt solution. When ready to sew up the wound be sure that all irritant fluids are removed (saliva in the mouth, etc.). Cleanse the wound with hot normal salt solution. The stitches must include

submucous tissue as well as the mucous membrane, and consist of silver wire. silk, chromic catgut, or silkworm-gut. After sewing up a wound in the mouth, wash the cavity at frequent intervals with salt solution, and follow each washing with an insufflation of iodoform.

In accidental wounds irrigate with salt solution, dust with iodoform, and close as directed above. Corrosive sublimate is so irritant that it does harm when applied to a mucous membrane.

Contused and Lacerated Wounds .- A contused wound results from a blow or a squeeze which bruises and crushes the tissues and splits or ruptures the skin. It is a common injury when force is applied to tissues over a bone. The blow of a blackjack may cause either a contusion or a contused wound of the scalp. A contused wound is irregular in outline, with jagged edges, and is surrounded by a broad zone of contusion. The worst form of contused wound is a crush of an extremity produced by being run over. The skin is often widely separated from the tissues beneath.

A lacerated wound results from tearing apart of the tissues. It too is irregular and jagged, and is accompanied by more or less contusion. A brush-burn is a contused-lacerated wound due to friction. Both lacerated and contused wounds contain masses of partly detached and damaged tissue, the vitality of which is endangered. Nerve-trunks, muscles, and great vessels may be torn across. Hence, such wounds are apt to slough, frequently suppurate, and are occasionally followed by cellulitis or even by gangrene. There is more danger of tetanus than in incised wounds. A wound especially apt to be followed by tetanus is made by the toy pistol. In contused and lacerated wounds the edges are discolored and cold to the touch, and there is little primary hemorrhage unless a cerebral sinus is opened or a great vessel is torn. There is considerable danger of secondary hemorrhage if large vessels have been bruised. In wounds of this nature the pain is often slight, but it may be violent. Shock is very severe.

Avulsion of a limb is a dreadful form of lacerated wound. The thumb or a finger may be torn off or the arm may be wrenched from the body with or without the scapula. In such cases the wound is large, jagged, and irregular, long strings of muscle or tendon hang from the gap, the wound edges are cold, but the bleeding is trivial. The shock is, of course, profound.

Avulsion of the scalp may be produced when the hair is caught in machinery. The American Indian inflicts this injury when he scalps a conquered foe. In some cases of avulsion of the scalp the periosteum is removed with the flap; in most it is not. The flap usually consists of skin and aponeurosis.

In this form of laceration there is severe bleeding.

Treatment.—The surgeon brings about reaction and endeavors to asepticize the wound and skin about it (page 268), arrests hemorrhage, and ligates any visible damaged vessel whether it bleeds or not. Hopelessly damaged tissue should be cut away, doubtful tissue being retained. In some cases amputation is necessary. If we apprehend tetanus, give an injection of antitetanic serum as a preventive. Secure thorough drainage, in some situations making counter-openings if necessary. Tube-drainage may be necessary or iodoform gauge in strands may be used. Contused wounds and lacerated wounds, except when on the face, are seldom closed by sutures. They are rarely closed, because the damage is so great and the blood-supply so interfered with that primary union will not occur. In the face the blood-supply is so good that primary union may be obtained in part or entirely, and it is worth while to try to obtain it. Cold must not be applied to a region of lowered vitality because might cause gangrene. Heat is useful. Hence, it is advisable, even from the start, to dress with hot antiseptic fomentations, and this mode of dressing becomes imperative if sloughing begins. Of course, the part must be kept at

If suppuration occurs, the surgeon sees to it that the pus has free exit, and if necessary secures free exit by making excisions. Bier's treatment and rest are useful for infections.

After avulsion of a limb the patient is reacted from shock, large vessels are sought for and tied, damaged tissue is cut away, the wound is packed with gauze and is partly approximated by sutures. After avulsion of the scalp bleeding vessels are carefully ligated. A portion of the scalp may be torn away, but a pedicle may connect it with the balance of this structure. In such a case cleanse the parts thoroughly and suture the flap in place (W. T. Bivings, "Phila. Med. Jour.," June 7, 1902). If the portion of scalp is entirely separated, adopt Gussenbauer's suggestion when possible and graft pieces of the avulsed scalp. In any case the ulcer resulting from avulsion must be repeatedly grafted. Abbe obtained healing in a case after four years by the use of 12,000 grafts.

Punctured Wounds.—Punctured wounds are made wth pointed instruments, as needles, splinters, etc. The depth of a punctured wound greatly

exceeds its surface area. After the withdrawal of the instrument inflicting the injury the wound partly closes at points, blood and wound-fluid cannot find exit, and if, as is probably the case, bacteria were deposited in the tissues, infection with pus organisms is very likely to occur, and if it does occur suppuration spreads widely. There is also danger of infection with tetanus bacilli. Such a wound may involve an important blood-vessel, and in such a case profuse hemorrhage may occur; otherwise hemorrhage is slight. A great cavity of the body may be penetrated or an important organ may be wounded. Large-sized foreign bodies may be driven into the tissues or a portion of the instrument may break off and lodge. Pain is rarely severe unless a considerable nerve has been damaged. If both a large vein and artery are punctured,

varicose aneurysm or aneurysmal varix may arise.

Treatment.—When possible, inspect the instrument which did the damage to see if a piece has been broken off. If there is severe hemorrhage, enlarge the wound and tie the bleeding vessels. In a puncture not made by the surgeon, the wound must be regarded as infected. If a wound is made by a dirty instrument through skin known to be unclean, it is proper that the skin about the puncture be sterilized, that the wound be enlarged, that foreign bodies be removed, that the wound be irrigated with an antiseptic solution, or be painted with pure carbolic acid, and be drained with a tube or a strip of gauze. Such treatment, though painful, and appearing unnecessarily severe or even cruel to the sufferer from a trivial puncture, is necessary, and may save the patient from serious illness or from death. Every deep puncture inflicted by an instrument not surgically clean, and every puncture inflicted by a nail, a splinter, a meat hook, a rusty pin, a tooth of a cat or dog, etc., must be regarded as grossly infected and must be treated by incision, sterilization, drainage, hot antiseptic fomentations, and rest. If the puncture is superficial and is made with a smooth pointed instrument like a needle, when the instrument was not grossly infected the parts may be dressed with hot antiseptic fomentations, but they should be inspected daily for evidence of infection and at the first sign of trouble an incision must be made. If a foreign body is retained in the tissue, it must be removed.

Pure carbolic acid is a most efficient agent to sterilize a punctured wound. If an important cavity of the body has been invaded by a puncture, exploratory incision is necessary (see Brain, Thorax, Abdomen). In punctures with contaminated instruments the antitetanic serum finds a valuable place as

a preventive of tetanus.

Stab-wounds.—Stab-wounds were formerly considered with punctured wounds, but Senn wisely placed them in a class by themselves. Stab-wounds are inflicted by penetrating the tissues with a pointed or narrow instrumentfor instance, a dagger, a knife, the blades of scissors, a bayonet, or a sword. Such wounds are narrow and very deep. A stab-wound may cause rapid death by penetration of a large blood-vessel. Some great cavity of the body may be penetrated and internal hemorrhage will then occur. The body may be transfixed by a sword or bayonet. Bone is rarely injured unless the skull is perforated or the chest entered. In stab-wounds there is usually great hemorrhage and shock.

Treatment.-Wherever possible, look at the instrument which did the damage and see if a piece is broken off. If no great cavity is entered, treat by general rules: arrest bleeding, react from shock, etc. The treatment of penetrating wounds of the abdomen, thorax, and cranium is discussed in the special sections.

Arrow-wounds.—Arrow-wounds might be considered under the head of punctured wounds or stab-wounds. When hostilities with the red men were frequent and before mercenary traders had fitted out the savages with rifles, arrow-wounds were common among the men of the frontier. They are now very rare. Military surgeons still encounter them, especially in some parts of Africa and in the Philippine Islands. An arrow-wound may be a trivial puncture of the skin, a deep wound of the soft parts with or without bone injury, a penetration of a joint, or of one of the body cavities. The skull cavity may be entered by an arrow. In some of these cases there is a puncture of the bone without the formation of fissures, but usually when bone is punctured there is fissure formation, splintering, or depression. A large blood-vessel may be divided by an arrow and violent bleeding result or fatal concealed hemorrhage may take place from a wounded viscus. Some tribes poison arrows. It is said that the Piutes were the only tribe of North American Indians which did this.

Some tribes in South America use curare, others use snake-poison, others use decomposed meat. In Northern Nigeria some form of strophanthus plays a part in nearly all the poisons used (Allan C. Parsons, in "British Med. Jour.," Jan. 23, 1909). The same author points out that the poison used is generally complex and contains also various animal and vegetable ingredients, particularly decomposed organic matter, plant juice containing strychnin, and soil contaminated with tetanus organisms.

Treatment.—An arrow is always septic and should be extracted. Sometimes when it has been buried deeply in a part it should be pushed across and extracted through a counter-opening after the protruding shaft has been cut off. An arrow head cannot be pulled out by the shaft. The barbs on the head catch and prevent extraction and the neck of the shaft is apt to break. The tissues should be freely divided down to the head of the arrow and on each side of it, when it can usually be withdrawn by forceps. If imbedded in bone, the head must be gently rocked from side to side to loosen it, every care being taken to avoid breaking a stone or bending an iron arrow head. If an arrow has penetrated the abdomen, a laparotomy should be performed. If it has entered a joint, the joint should be freely opened. If it has entered the chest, one or more ribs will require resection. If it has entered the skull, trephining is indicated. Any bleeding vessels are to be caught and tied. The track of the arrow should be disinfected with pure carbolic acid and drainage should be inserted. It is particularly important to remove a poisoned arrow at once. After removing a poisoned arrow, if the nature of the poison is known, proper treatment should be applied to antidote the poison. The French Colonial surgeons fill wounds inflicted by poisoned arrows with tannic acid. The same custom is followed by English surgeons in West Africa (Allan C. Parsons, Ibid.).

Gunshot-wounds.—Gunshot-wounds are contused or contused-lacerated wounds inflicted by materials projected by explosives. A bit of rock or a crowbar hurled by dynamite inflicts a gunshot-wound, as does a shell-fragment, a pistol-ball, small birdshot, a rifle bullet, pieces of a hand grenade, a flying cap, a piece of wadding, grains of powder, a buckshot, a fragment of metal broken off a shell, grapeshot and canister, or a cannon-ball. Injuries

by shell-fragments, portions of a bursted boiler, pieces of masonry or wood, are either lacerated or punctured wounds, and need no special consideration here. In this article we treat of injuries caused by bullets and shot, that is, by missiles propelled from firearms.

Firearms are instruments by means of which missiles are projected to a distance by the expanding gases of burning gunpowder. There are many different sorts of firearms. Artillery includes various sizes of guns upon supports, from the great 12-inch guns of a battleship, which fire shells weighing 850 pounds, to machine-guns, which fire ordinary rifle bullets. Field artillery uses little but shrapnel-shells. Such a shell is a case of steel, cylindroconoidal in shape, containing a number of bullets and a charge of explosive, the shell exploding by means of a time-fuse. Canister is an iron casing containing bullets unassociated with an explosive discharge within the casing. The canister breaks when fired, and the balls separate over a large area. It is used only at close range—that is, three or four hundred yards.

Among small arms may be mentioned muskets, revolvers, shot-guns, and rifles. Wounds from the old-time musket ball are now never met with except in warfare against barbarous tribes. The musket has a smooth bore and fires round bullets of soft lead. This round, soft bullet, being large, moving with comparative slowness, and flattening easily, is very liable to glance, to deform, and to lodge. When a musket is fired at close range and the bullet strikes the tissue at a right angle, it produces a punched-out entrance wound. If the velocity is low or the impact is not at a right angle to the tissues, the entrance wound may "be formed of triangular flaps," the corners of which are inverted.\* The entrance wound is surrounded by a bruised area. The track of the bullet is larger than the bullet, and is so badly contused and lacerated that some tissue is devitalized; and the shaft of a bone, if struck, is likely to

be splintered. If the ball emerges, the wound of exit is larger than the bullet, and forms triangular and everted flaps. Healing by first intention seldom

occurs in such wounds. The old smooth-bore musket, firing a round bullet, has been displaced by the rifle propelling a conical projectile.

In the firearms of civilians, as a rule, the bullets are made of lead, hardened and shaped by compression, or hardened by an admixture with tin. The conical or cylindroconoidal rifle bullet has much greater velocity and penetrating power than the round bullet. Hence, it is more liable to penetrate and less likely to deflect and to lodge. The track of this bullet is less devitalized than is the track of the round bullet. The cutaneous surface is not so much contused. The wound of entrance is smaller than the bullet, and is punched out or inverted; and the wound of exit is larger than that of entrance and is often everted. The bones are more seriously comminuted than by the round bullet, and osseous fragments may be driven widely into the tissues. In fact, "an explosive effect" may occur at close range. Delorme lays it down, as a rule, that comminution of bone makes the wound of exit larger; and he asserts that a wound of exit larger in diameter than the thumb means comminution of bone.

Gunshot-wounds Seen in Civil Life.—Wounds are occasionally inflicted with the sporting rifle or the shot-gun, and frequently with blank cartridges;

<sup>\*&</sup>quot;Wounds in War," by Surgeon Col. W. F. Stevenson.

but the vast majority of such wounds seen by the civilian surgeon are inflicted with the revolver.

Wounds from the Sporting Rifle.—In the sporting rifle a large charge of powder is employed. Some sporting rifle bullets have no hard jackets. Others have an incomplete hard jacket. In a bullet with a partial hard jacket the "nose" of the bullet is exposed and soft. The bullets are usually larger than those used in the military rifle. Such bullets deform in the tissues, and inflict dreadful, tearing wounds. If such a bullet strikes a limb, amputation may be required. If it strikes the head or trunk, it will almost certainly produce a fatal wound.

Wounds from the Shot-gun.-The degree of injury is in direct ratio to the adjacency of the wounded individual to the gun when the discharge takes place; to the size and number of the shot; and to the charge of powder. Single shot may bruise the surface and fail to enter the tissues or may enter the tissues. When many shot enter together, they strike as a solid body. Single shot are usually deflected from vessels and nerves, and seldom lodge in bone; but, rather, flatten on the bone surface. Even a single shot lodged in the eyeball is apt to produce violent inflammation which may destroy the eye. Numerous shot entering together at close range produce extensive contusion of the surface and fearful lacerations of the tissues, and often inflict irreparable damage. Bone may be fractured and bits of clothing or other foreign bodies may be carried into the wound with the shot. At close range toes or fingers may be blown off, an eye may be blown out, or portions of tendon or muscle may be shot away. Primary hemorrhage is seldom severe because the wound is becrated; but secondary hemorrhage is to be feared, and serious infection usually follows such injuries. Buckshot at close range inflict grave or dreadful wounds. The United States Army is supplied with a cartridge for use in riots. This cartridge contains two shot, each about the size of a buckshot.

The Treatment of Shot-gun Wounds.—If the shot be scattered and lodged it is seldom necessary to remove them. As a rule, such cases require only deansing of the skin and aseptic dressings. If shot lodge in a joint, they impair function; if in the face, they produce deformity. In both of these cases removal is necessary. When a shot lodges in the eye it usually, but not always, causes blindness. If the eye is gravely damaged it must be enucleated. In serious lacerations produced by shot at close range the hopelessly damaged assue must be cut away, hemorrhage must be arrested, foreign bodies must be removed (though no protracted search is either necessary or desirable to remove grains of shot), the wound must be disinfected as well as possible, and free drainage must be employed. It is wise to give a prophylactic dose of antitetanic serum.

Blank-cartridge Injuries.—These injuries can occur only at close range. They consist of burns and lacerations, frequently a wad or a bit of clothing lodges in the tissues, and tetanus is a not unusual sequence. The explosive may be driven quite deep into the tissues. There is considerable danger of tetanus after injuries inflicted by the toy pistol. What in the United States is called "Fourth of July tetanus" is tetanus following such an injury, the small boy being prone to employ a toy pistol to contribute noise to the celebration of the nation's birthday (see page 219).

Blank-cartridge wounds and toy-pistol wounds are treated by cleansing the skin, enlarging the wound, removing foreign bodies, disinfecting, and draining. A prophylactic dose of antitetanus serum should always be given.

Wounds Inflicted by the Revolver Bullet.—The revolver varies in caliber from .22 to .45. Whereas it is true that certain military revolvers of the automatic type fire a hard-jacketed rifle bullet, the revolvers of civil life propel cylindroconoidal unjacketed bullets at a velocity of about 700 feet a second. A revolver bullet never produces an explosive effect. It is liable to deform in the tissues, is often deflected from bone or tendon, and is very apt to lodge. The shape of the bullet, the velocity with which it is propelled and with which it rotates, and its hardness, make it unlikely that at any near range the bullet will merely contuse, and not enter, the skin. Unless striking at an angle to the perpendicular, it will almost always enter. In some cases, however, a pistol bullet, like a spent rifle bullet, may fail to enter the tissues. It then grazes the surface and inflicts a brush burn or simply contuses the part. Sometimes it perforates, more often it lodges. Whereas it may be deflected, it comparatively seldom is; and it often deforms, though it does not do so to anything like the degree that the soft, round bullet does. If a bullet enters the tissues, a cavity, or an organ, and lodges there, it causes a penetrating wound. If it enters and emerges, it causes a perforating wound. The bullet may not enter alone, but may carry with it bits of clothing or other foreign bodies; though this complication is much rarer in injury with the conical bullet than with the round ball. On one occasion I removed a piece of coat from the interior of the lung, to which it had been carried by a pistol bullet. In another instance I removed a piece of shirt from the interior of the abdomen, to which it had been carried by a similar bullet. A revolver bullet may break bones, though it is not nearly so liable to do so as is a rifle bullet.

In studying a gunshot-wound one must consider the wound of entrance, the tissue track, and, if the bullet has emerged, the wound of exit. If a revolver bullet fired from a distance of ten feet or more from the person struck hits the skin at a right angle, it makes a wound of entrance that is smaller than the bullet because the skin is elastic. It is a certain fact that one cannot assert from an inspection of the wound of entrance what size bullet a man was struck with. A .22 often leaves a most trivial opening. The shape of the wound of exit is somewhat, but not regularly, circular, because a certain amount of tissue is destroyed. The margins are also somewhat depressed. It has a punchedout look, and the edges, as Draper tells us, are frayed in appearance ("Textbook of Legal Medicine," by Frank Winthrop Draper). The edges of the wound look thickened and are contused, this discoloration being noted for a distance of an inch, or even two inches, from the margin of the wound. The skin surface is distinctly blackened; but unless the weapon were fired at very close range, this is not due to burning, but rather to staining with a mixture of burnt gunpowder and the grease of the outer surface of the bullet. The appearance of the wound of entrance will be very different if the bullet strikes the surface at an acute instead of a right angle. Then the wound will not be round, but oval or, perhaps, linear. When a bullet is fired very near to the surface of the body the hair of the skin will be burned, there will be some staining with gunpowder around the wound, and powder-grains will be found lodged in the skin. Whether the weapon inflicting the wound was close or

distant there is bruising of the skin, but when the powder is found in the tissues or on the surface, it means that the weapon was close at the time of discharge. The absence of imbedded powder, however, does not prove that the shot was not close, because the weapon employed might have been one using smokeless powder. If the weapon were fired at close range the skin may have been burnt by burning gases or the clothing may have been burnt and the skin scorched by the burning clothing. Staining of the skin with powder can be washed off, but when the skin has been burnt it is dry like parchment. When unexploded powder-grains are lodged in the skin the resulting condition is spoken of as tattooing, and this always means a very close shot. It has been held by some that powder-grains are never found in the skin unless the bullet has been fired from a distance of less than 3 feet, but this is too arbitrary a statement to make in a court of law. In any medicolegal case experiments should be made with a weapon and ammunition similar to those used in inflicting the wound in order to determine the real facts of the case. Draper ("Text-book of Legal Medicine") makes the following important statement relating to burns of the skin, which, I am convinced, s corrects "If the weapon is held in the hand in the ordinary way, hammer and sight on the barrel directed upward, the wound in the skin will show, immediately above its orifice, a brand or scorching caused by a slight recoil in the act of firing. The location of this brand will change as the position of the hammer is changed. If the weapon is held in a vise and fired, this relation of the brand to the wound is obliterated. This observation, first made and published by Dr. D. B. N. Fish in 1883, supplies an accurate index of the position in which the pistol is held in firing." In passing through the tissues the revolver bullet makes a contused lacerated wound, and we may find along this wound powder-grains (if the bullet has been fired at close range) and portions of clothing, pieces of the bullet itself or perhaps of bone. A bullet may pass directly through both walls of the skull, traversing the brain in its passage. It may pass through a line of the side of the skull and lodge within the cavity of the cranium. In some cases it makes an opening of entrance that is smallest on the external surface of the bone and largest on the inner table. In other cases it makes extensive comminuted fractures. When a bullet tracks its way through a muscle it makes a jagged, contused, lacerated wound. It does the same in the brain. In both cases the track of the bullet is larger than the bullet, and the tissue for a considerable distance wide of the track is contused or actually destroyed. In passing through an aponeurosis or a scrous membrane the bullet may make a round orifice or a slit-like tear. Of course, the nature of the wound in the tissues will be greatly affected if the bullet is deformed by having struck bone, or if it carries bits of bone along with it. The deflection of a bullet from an aponeurosis, fascia, or bone so alters its course that the missile becomes very difficult to locate and remove. In some cases a bullet has entered near the front of the body and passed around the wall of the chest until it has almost reached its point of entrance, or else has emerged at some point of this course-in either case constituting what is known as a contour wound. Contour wounds are not infrequently seen upon the head. For instance, a bullet may strike the frontal region, pass around untler the scalp, and lodge in or emerge from the occipital region.

When the bullet does not lodge, but emerges from the body, the wound of

exit must be studied. If an undeformed bullet passes straight through the body it makes a wound of exit that is somewhat larger than the bullet. It has a torn-out appearance, but without distinct destruction of tissue, and exhibits an irregular outline and eversion of the edges. The margins of such a wound are bruised, but are never scorched and never show powder-grains. If a bullet has been deformed by hitting bone, or if it has driven bone before it, a very large lacerated wound of exit may be formed. It is important to remember that the presence of a number of wounds on the surface of the body does not in itself prove that a number of different bullets have been fired, for in certain circumstances one bullet may make several wounds. A few years ago I saw a case in which a bullet had penetrated the right hand and the right thigh, and had lodged in the left thigh. There were three wounds of entrance and two wounds of exit. Many very extraordinary cases of this sort have been reported.

Symptoms of a Gunshot-wound.—Hemorrhage is often considerable, but ceases spontaneously unless a large vessel has been divided. If hemorrhage is profuse, the constitutional symptoms of hemorrhage exist (page 435). These symptoms are of great importance in abdominal wounds. A pistol ball seldom causes severe primary hemorrhage, because it will not often penetrate a large artery. It is apt to push aside a vessel, and secondary hemorrhage is not unusual. Even if a large vessel is wounded and a succession of violent hemorrhages occur, a man may live for several days. Secondary hemorrhage may follow a gunshot-wound because of contusion of vessels or of infection.

Pain is often not noticed at first. The injured individual, if greatly preoccupied or excited, may not know that he has been struck by a bullet. There may be only a feeling of numbness, but usually there is a dull or stinging pain. If a large nerve has been injured there may be violent pain. Even trivial gunshot-wounds frequently produce profound shock, and yet it may happen that severe wounds may be accompanied by but slight shock. In most gunshot-wounds of the brain, abdomen, and spinal cord the shock is very great.

General Considerations as to Treatment.—The dangers are shock, hemorrhage, and infection. Bullets are aseptic when they enter a part, and if infection is not inserted in the track of the ball the wound will in most instances heal kindly. "The fate of a wounded man is in the hands of the surgeon who first attends him" (Nussbaum). The danger of a wound depends upon the size and velocity of the bullet, the part struck, "and the degree of asepsis observed during the first examination and dressing" (Nancrede). The rules of treatment are: bring about reaction, arrest hemorrhage, preserve asepsis, and, in some cases, remove the ball. Always notice if a wound of exit exists. It is a good plan, when endeavoring to determine the extent of injury, to put the parts in the position they were in when the injury was inflicted. We should try to ascertain the size and nature of the weapon, and the range at which it was fired. Examine the clothing to see if any fragments are missing and could have been carried in. Such fragments render sersis almost inevitable. The surgeon must not feel it his duty to probe in all cases. In many cases it is better not to probe at all. Explore for the ball when sure that it has carried with it foreign bodies; when its presence at the point of lodgment interferes with repair; when it is in or near a vital region (as the brain); and when it is necessary to know the position of the bullet in order to determine the question of amputation or resection. If the wound is large

enough, the finger is the best probe.

Fluhrer's aluminum probe is a valuable instrument (Fig. 113). It is employed especially in brain-wounds, and is allowed to sink into the track of the ball by the influence of gravity after the part has been placed in a proper position. If a lead bullet is deeply imbedded, it is possible to distinguish the hard projectile from a bone by inserting the asepticized stem of a clay pipe, a bit of pine wood, or Nélaton's porcelain-headed probe (Fig. 111). On any one of these appliances lead will make a black mark. No such test can be applied to a military bullet, for this has a hard metal jacket, and will not make a black mark on a white substance.

Though Nélaton's probe will not show the difference between a hard projectile and bone, it is a valuable instrument to follow the track of a wound. The porcelain head ought to be larger than it is usually made-in fact, it should be nearly the size of the bullet (Senn) (Fig. 112).

In passing a probe use no more force than in passing a catheter.



Fig. 113.-Fluhrer's aluminum gravitation probe (natural size, except the length, which is twelve inches).

The induction balance of Graham Bell has been employed to determine the situation of a bullet. The bullet may be located by Girdner's telephonic probe. In order to construct this instrument, take a telephone receiver, fasten one of the wires to a metal plate and the other one to a metallic probe. Moisten a portion of the patient's body and place the metal plate in contact with it. The surgeon places the receiver to his ear and inserts the probe into the wound. If the probe strikes metal, a click is heard with distinctness. A bullet may be located by Lilienthal's probe. This apparatus consists of a mouth-piece, two insulated copper wires, and a probe. The mouth-piece is composed of two plates, one of copper and one of zinc, which are applied to the sides of the tongue. An insulated wire runs from each plate and into the metal probe. The tip of the probe is composed of two or four pieces of metal, is separated from the shank by a washer of rubber, and is attached to the wires. The operator closes the teeth upon the mouth-piece, and inserts the probe into the wound. If the probe touches the bullet, a distinct and continuous metallic taste is appreciable.

The best means of discovering a bullet is to use the fluoroscope or take a

skiagraph. In order to locate it accurately, view it through a series of squares, insert guide-pins, or, better than either of these plans, employ Sweet's apparatus. Bullets are readily seen by the fluoroscope in the superficial soft parts, and are discovered in deeper structures (bone, abdomen, lung, brain, etc.) by taking skiagraphs.

In extracting the ball use very strong forceps (Fig. 114). The old American bullet-forceps is useless for the extraction of the hard-jacketed ball, as the

points will not penetrate and the instrument will not hold.

If hemorrhage is severe in a gunshot-wound, enlarge the wound, find the bleeding vessel, and tie it. Before handling a gunshot-wound asepticize the parts about it and irrigate the wound with hot sterile salt solution. In some situations a wound should be drained with a short tube or a bit of iodoform gauze; in other regions this is unnecessary. The dressing should be antiseptic. Primary union rarely takes place after a wound inflicted by a pistolball or an ordinary rifle-ball, because of the inevitable necrosis of damaged tissue in the track of the ball, but in some cases it can be obtained. Primary



Fig. 114.—Bullet-forceps.

union is frequent after injury by the small hard-jacketed modern projectile Healing begins in the depths of the wound and extends toward the wound of entrance, or, if there be also a wound of exit, toward both. Radical operations may be demanded: laparotomy, trephining, rib-resection, joint-resection, or amputation.

Amputation is sometimes demanded because of great injury to the soft parts (as by a shell-fragment), the splintering of a bone, injury of a joint, damage to the chief vessels or nerves, or the destruction of a considerable part of a limb. Perform a primary amputation if possible, and make the flaps through tissue that will not slough. In civil practice, with careful antisepsis, more questionable tissue can be admitted into a flap than in military practice, where transportation will become necessary and antisepsis may be imperfect or wanting. It has been shown in recent years that even when a large joint has been perforated by a small hard-jacketed projectile, amputation or resection is rarely required if the wound was treated aseptically from the beginning, but this is scarcely true of the revolver bullet.

Wounds by Cannon-balls.—A cannon-ball weighing five or six pounds may be imbedded in tissues. A ball or shell fragments may tear off a limb or lacerate it extensively. In some cases of injury by spent balls the bone is

destroyed and the muscles disorganized while the skin is intact.

Wounds in War Inflicted by Rifle-bullets.—During the last few years frequent and notable improvements have been made in the military rifle. The range and rapidity of firing have been vastly increased, the velocity of the projectile and its penetrating power have been enormously added to, and the trajectory has been decidedly lowered. Hence, the zone dangerous to an

enemy has been lengthened. In order to accomplish these things, changes have been made in the gun, the explosive, and the projectile. It is a far cry from the old Brown Bess, of song and story, to the modern Lee-Enfield of the British army, or the Springfield of the United States army. All modern military rifles are of small caliber; that is, less than .35 in. The Springfield rifles of the days of the war between the States had a caliber of .45 in. The old Springfield projected a bullet at an initial velocity of 1300 feet a second; whereas the modern rifle sends a projectile on its way with an initial velocity of from 2000 to 2300 feet a second, the bullet rotating on its long axis 2500 times during the first second of translation. At a range of 50 feet, such a bullet will penetrate 54 inches of pine wood; and at 1000 yards, it will penetrate over 13 inches of pine wood (Surgeon-General O'Reilly, of the United States Army, in "Keen's Surgery," Vol. IV.). Up to 5000 yards a modern rifle can inflict a fatal wound, and it can be used point-blank at a range of from 500 to 600 yards. A bullet from a modern military rifle, even after having struck some solid, hard hody, may grievously injure a man by ricochet. With a magazine rifle, at 2500 yards, from 5 to 10 per cent. of the balls will ricochet from turf. At 3000 yards, they will bury in turf, but may ricochet from very hard ground. The United States army now uses a magazine Springfield that weighs less than o pounds. The barrel is 24 inches in length, and the diameter of the bore is 30 inch. The rifling makes one complete turn in every 10 inches. With this weapon, by magazine fire, 25 aimed shots may be fired in a minute; and when used as 2 single-loader, 23 aimed shots (Surgeon-General O'Reilly, U. S. A., in "Keen's Surgery," Vol. IV.).

Old-fashioned Black Gunpowder as Compared with Smokeless Powder.—
There are many different varieties of smokeless powder, but each is essentially a nitro-powder. Among these smokeless powders are melenite, used by the French; lyddite, employed by the British; and shimose, adopted by the Japanese. The United States forces use cellulose nitrate in perforated cylindrical, amber-colored grains. Nitro-powder is very nearly smokeless because all the products of its combustion are gases. Of the products of the combustion of black gunpowder, 57 per cent. by weight settle out from the atmosphere

in solid form on cooling.

There are great advantages in the use of smokeless powder. It is much more powerful than black gunpowder; hence, a smaller charge can be employed. The modern Springfield requires a charge of 44 grains; and at the time of the discharge the pressure in the chamber is about 40,000 pounds to the square inch. Smokeless powder gives the bullet a greater velocity, causes less recoil, and fouls the barrel infinitely less than black powder; and the absence of smoke maintains a clearer atmosphere for observation, and also furnishes no sign of location which might prove of advantage to the enemy.

Projectiles.—The bullet of a modern rifle is conical, has a lead core, and is hardened by being covered with a mantle or jacket of copper, steel, or nickel, or of alloys of copper and nickel, or of copper, nickel, and zinc. The hard jacket is absolutely essential, because the speed of the projectile is so great that no soft bullet would take the rifling. Fragments would be torn off from the bullet in the gun, and the grooves of the gun would soon be filled with metal, the gun becoming useless. The projectile of a modern Springfield rifle is elongated, and has an ogival head of infinite radius. The air-resistance is

MAGAZINE RIFLES OF SMALL CALIBER.

Country	:	United	England	England Germany	France	Russia	Italy	Austria, Bulgaria, Greece	Spain	Portugal	Belgium	Rou- mania	Turkey	Holland	Japan
Pattern	:	Spring- field	Short Lec- Enfield	1888	الم الم	3 Line Nagant	Männ- licher carcano	Männ- licher	Mauser	Kropat- sheck	Mauser	Mann- licher	Mauser	Männ- licher	Year 30
Date		1903	<b>£</b> 061	1888	1886	1891	1681	1888	1892	1886	1889	1892	1890	1892	900
No. of bullets .		8	2	v	<b>∞</b>	w 	•	<b>v</b>	'n	0,	×	10	8	50	s
Magazine system	ea	Ciip	Charger	Ciip	Tube in fore end	Charger	Clip	Ciib	Charger	Tube in fore end	Charger	Clip	Charger	Clip	Charger
Length of barrel	rel	2 <b>4</b> in	61.52	29 134	31.496	29.62	30.75	30.12	g,	31.633	30.67	28.74	29.134	31.1	
Caliber		ni oč	.303	311	.315	œ.	.2569	.315	.2756	.315	.30r	.2569	.3012	.2569	.256
Sigh.	( Point-blank	200 yds.	8	273	. 273	310	437	246	437	328	24.	437	273	437	
singic	Extreme.	:	2800 yds	2243	2187	3005	2187	2460	2187	2406	2187	9622	2187	9682	2187
Weight withor	Weight without hayonet	8 lb. 14 oz.	8, 21/2	8,6	9, 31/5	8, 13	8, 6	17 6	8,9%	10, 3	8, 9,7	8, 71/2	8, 91/4	%	
)	( Material of core	Lead, tin	Lead	Lead	Lead	Lead	Lead	Lead	Lead	Lead	Lead	Lead	Lead	Lead	
Bullet	Envelope	Cupro-	Cupro- nickel	Steel, cupro- nickel	Cupro- nickel	Cupro- nickel	Cupro- nickel	Steel lubricated	Steel, nickel	Steel	Cupro-	Steel, cupro- nickel	Cupro- nickel	Steel, nickel	Copper
_	Weight	220 grs.	215	227	316	214	163.5	#	172.8	848	919	ğ	213	162	162.9
Weight of cha	Weight of charge	‡	31.5	<b>#</b> 3. <b>#</b>	41.66	33	31.6	43.4	37.8	70 black	4	36.26	40.2	36.26	_
Muzzle velocit	Muzzle velocity (ft. secs.)	3300	3000	**************************************	<b>807</b> 3	\$608	395	\$6034	2288	1750	 <b>7</b> 60	3395	2139	395	3362
Pressure in per square i	Pressure in chamber, tons per square inch	2	15.75	<b>ä</b>	17.73	51.01	17.1	1.61	82.3	15.75	19.7	:	r.62	· •	

(Adapted, with modifications, from Spencer's "Gunshot Wounds" and Stevenson's "Wounds in War.")

least in a bullet of this shape. The core is composed of lead hardened with tin, and its jacket is of nickel and copper.

The military surgeon deals with wounds inflicted with these small, dense, hard, conical projectiles, impelled with great velocity, and carried long distances. The old bullet was liable to lodge, was often deflected in the tissues, was flattened out on meeting with resistant structures, such as bone or cartilage, and, after flattening, became larger, tearing and lacerating the soft parts and comminuting the bone. The modern projectile is likely to penetrate, is rarely deflected, and is so hard that its shape is often but little altered on meeting with resistant structures. Hence, it was thought that the new bullet would prove more humane than the old projectile and inflict wounds that would



Fig. 115.-t, Krag-Jorgensen; 2, new Springfield.

be more easily treated, because the bullet would be unapt to lodge and extensive damage would seldom be inflicted. This view has proved, to a great extent, correct.

With the modern rifle of small caliber and the hard projectile propelled by smokeless powder the range has been notably increased, the trajectory of the bullet's flight has been greatly lowered, and the danger-zone to an enemy has been correspondingly lengthened.

Mechanics of Projectiles.—If a moving bullet were acted upon by no force but propulsion, it would continue to move in the direction that it was pursuing when it left the muzzle of the gun and its course would be a straight line, but it is acted upon by other forces. Even in a vacuum its course would not be a straight, but a curved line, because gravitation would draw it toward the earth. Under ordinary circumstances the air also resists its forward progress.

A moving bullet is urged onward by the force of the exploding powder. This onward movement is called the motion of translation. The rate of for-

ward movement is the *velocity*, and this is expressed in feet per second. Airresistance causes the velocity to lessen rapidly, and the farther away from the gun the projectile is, the greater is its loss of velocity. For instance, on leaving the muzzle of the Lee-Enfield rifle, a bullet has a velocity of 2060 feet a second (*muzzle velocity*); at 700 yards, it has a velocity of 1039 feet a second; at 2000 yards, 571 feet a second; at 3000 yards, 369 feet a second ("Gunshot-wounds," by Major C. G. Spencer). The velocity of a bullet at any particular portion of its flight is called *remaining velocity*.

A bullet fired from a rifle rotates on its long axis. This rotation is called *spin* or the *movement* of *rotation* and is in the direction of the groove of the rifling. It is this motion that keeps the point of the bullet toward the front and prevents rotation on its short axis, which would be responsible for increased air-resistance, diminished striking force, and lessened range. If a cylindro-conoidal bullet were fired from a smooth bore, it would rotate on its short axis at even as short a range as 9 yards, and would strike a target in its length (Stevenson's "Wounds in War").

The diminution in the transverse diameter of bullets has necessitated an increase in length in order to maintain their weight and sectional density. (Sectional density is the weight divided by the area of the cross-section.) The increase in length makes an increased rapidity of rotation indispensable. The higher the pitch of the rifling, the more rapid the rate of rotation imparted to the bullet. The Minié rifle had a complete turn in 78 inches. The United States Army Springfield has a complete turn in 10 inches. The velocity of spin as the bullet leaves the barrel of a Springfield is about 2500 times a second. The velocity of rotation changes as the velocity of translation changes; and when translation ceases, because the energy of propulsion has expended itself, rotation also ceases. "But when the motion of translation is suddenly and completely arrested by contact with an obstacle, then, if the bullet is not broken up, the motion of rotation continues until its energy is expended" ("Wounds in War," by Surgeon-General W. F. Stevenson, C. B., A. M. S.). A rifle bullet in its flight deviates a little laterally, and in the direction of the groove of the rifling. In the U.S. Army rifle the groove of the rifling is toward the right when the gun is held with the butt toward one; hence, the deviation of the bullet is toward the right. This lateral deviation is called drift.

Influence of Gravity and Air-resistance.—We have previously stated that, even if moving in a vacuum, the line of flight of a bullet (the trajectory) would be a curved and not a straight line, because of the influence of gravity, which pulls the bullet toward the earth. The bullet would fall 16 feet the first second, 48 feet the second second, 80 feet the third second, and so on. A bullet moving forward in a vacuum would advance through equal distances in equal periods of time, and, as gravity would draw it toward the earth with increasing rapidity, the trajectory would be a parabola (Fig. 116, line A–E–F–G).

Air-resistance strongly retards the advance of a bullet and causes it to lose its velocity rapidly, and a bullet fired in air does not advance through equal distances in equal periods of time. Because of air-resistance a bullet falls to the earth sooner than it would under the influence of gravity alone. Hence, the trajectory of a bullet in air is not a true parabola, but the line of descent is much nearer to the vertical than would be the case in a vacuum (Fig. 116, line A-e-f-g).

Air-resistance depends upon the velocity of the bullet, the cross-section area of the bullet, the shape of the head of the bullet, the atmospheric density, and the steadiness of flight ("Gunshot-wounds," by Major C. G. Spencer). Air-resistance is least in the bullet that tapers rapidly. A bullet begins to lose its steadiness of flight about 1000 yards from the muzzle of the rifle.

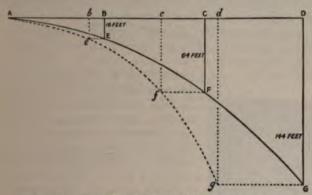


Fig. 116.—Trajectories in vacuo and in air (Stevenson).

The Danger Zone.—Owing to the fact that the trajectory is a curved line elevation must be given to rifles except at point-blank range; and the degree of elevation must be increased according to the range. Point-blank range for a springfield is about 600 yards. By this term is meant that when a gun is aimed horizontally the entire course of the bullet up to 600 yards is dangerous for infantry. For longer ranges the rifle must be elevated and the bullet "shot into the air." It becomes evident that when a rifle is elevated the bullet rises far above a man's head, and continues to rise to what is known as the culminating point, when it begins to descend. It does not become dangerous to men until it gets near to the earth. The point at which it becomes dangerous to cavalry

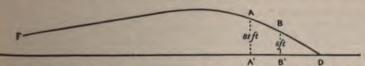


Fig. 117.—Trajectory, showing dangerous zones: A-B-D, Trajectory of bullet; D, point of termination of the bullet's flight; A-B, point of first catch for cavalry; B, point of first catch for infantry; A'-D, dangerous zone for cavalry; B'-D, dangerous zone for infantry (Specer).

is called "the point of first catch for cavalry" (Fig. 117). The point at which it becomes dangerous for infantry is called "the point of first catch for infantry" (Fig. 117). The dangerous zone (Fig. 117) is from the point of first catch to the termination of the bullet's flight, because anywhere in this zone men may be truck, but between the point of first catch and the man firing the gun, soldiers are perfectly safe. The point of first catch for cavalry is about 8½ feet and for infantry about 6 feet above the ground.

The more nearly vertical the line of the bullet's descent, the shorter is the danger zone; the less vertical the line of descent, the longer is the danger

zone. The higher the culminating point of the trajectory, the more vertical is the line of descent; hence, the shorter is the danger zone; the lower the culminating point, the flatter is the trajectory, and the less vertical the line of descent; hence, the longer the danger zone. The chief object of improvements in rifles is to lower the trajectory (that is, make it less curved) and thus lengthen the danger zone, render marksmanship more accurate, and insure velocity.



Fig. 118.—Trajectories of bullets from certain rifles: 1, Trajectory of Lee-Enfield at 1500 yards, action-point, 81 feet; 2, trajectory of Martini-Henry at 1500 yards, action-point, 178 feet; 3, trajectory of Lee-Enfield at 2000 yards, action-point, 194 feet; 4, trajectory of Martini-Henry at 2000 yards, action-point, 357 feet; 5, trajectory of Snider at 2000 yards, action-point, 866 feet; horizontal scale, \(\frac{1}{24,000}\) (1 inch=2000 feet); vertical scale \(\frac{1}{12,000}\) (1 inch=1000 feet). Vertical measurements are represented on twice as large a scale as horizontal measurements (Spencer).

Power of the Bullet to Wound .- According to Spencer (Ibid.), this depends upon its energy and the ease with which its energy is converted into work on striking. Energy is largely a matter of range. At short range energy is enormous, but it rapidly diminishes as the range is increased. At 3000 yards energy is only about one-sixteenth of what it is at 300 yards. The ease with which a bullet converts energy into work depends upon (see Spencer, on "Gunshot-wounds"): (1) The area of the cross-section of the bullet. The larger the bullet, the worse the wound. (2) The deformation of the bullet. Such deformation enlarges the area. A bullet that expands on striking is said to "mushroom." The modern bullet seldom deforms much unless its jacket has been more or less torn off; and it inflicts, as a rule, a much less grave injury than does the soft bullet. It has been found that this very humanity of the bullet is at times regarded as an objection. The bullet lacks "stopping power" unless it strikes a vital part or a large bone, and a wounded man may continue to fight and charge. Civilized men will usually stop when hit, but savages very often will not. Hence, in warfare with barbarous people, it was until recently the custom to modify the bullet. A portion of the bullet at the apex of the projectile was left exposed, and such a bullet was said to be uncovered or to have a "soft nose." It was called a Dumdum bullet, because such missiles were first made at Dumdum, the ordnance factory near Calcutta. When a Dumdum bullet strikes, it spreads and expands, or "mushrooms," and inflicts an extensive and dreadful wound, which stops the most ferocious savage or the most fanatical tribesman. These expanding bullets are often wrongly called "explosive bullets." They have been forbidden by The Hague Convention, although Stevenson and some other surgeons maintain that they are more humane than were the bullets of the Snider or the Martini-Henry rifle.

(3) The Resistance Encountered.—If energy is great (as at close range)

and a very resistant tissue is struck (bone), dreadful injury may be inflicted, but if a tissue with little resistance is struck, but little damage may be done. At a long range the energy of the bullet is so lessened that the danger to resistant tissue will be much less; whereas injury of soft parts will be much the same as at close range.

The Nature of the Wounds Inflicted by the Small Projectile.—The effect of lesening the size of the bullet is to decrease its wounding power, because, other things being equal, the larger the bullet, the greater its wounding power. In many instances the modern bullet will make a clear track, without laceration or comminution. It was thought, as has been stated, that this projectile would prove humane, that it would kill comparatively few, and that the

wounded would receive injuries which would incapacitate them, but from which most of them would subsequently recover. Recent wars have indicated that at a range of over 1500 yards the bullet, as a rule, penetrates deanly, making a wound that heals by first intention. Sir Frederick Treves expressed his experience by saying, "the Mauser bullet

is a very merciful one."

Very many studies have been made of the action of the modern bullet, and numerous experiments have been carried out-firing through boxes filled with wet sand, firing into thick oak, firing at cadavers at fixed distances with reduced charges, and firing at corpses and at live horses with service charges. Nancrede, some years ago, wisely cautioned us to remember that experiments upon the cadaver, employing reduced charges and standing at fixed distances, are uncertain in their provings. "The difference," he said, "between the velocity of rotation and the angle of incidence with reduced charges at fixed distances and service charges



Fig. 110.-Mauser bullet-wound of chest: a, Wound of entrance; b, point where bullet was extracted (Major Charles F. Kieffer, U. S. A.).

at actual distances is marked. The tension of living muscle and fascia, as compared with dead tissues, and the physical change of the semiliquid fat of adipose tissue and medulla to a more solid condition by the loss of animal heat, influence the results" (Nancrede, "Gunshot-wounds," Roswell Park's, "Surgery by American Authors").

All the theoretical conclusions derived from experiment and the observations made on the occasional victims of suicide or homicide have been put to the test of war in recent years; and we now draw our deductions from a study of the wounds in the Chitral Expedition, the Greco-Turkish War, the Spanish-American War, the South African War, the taking of Pekin, and the Russo-Japanese War. Preconceived opinions have, to a great extent, at least been confirmed. It has been found that the wounds are usually non-infected and are apt to heal by first intention unless inflicted by ricochet, which deforms the bullet. At a range of 1500 yards or more the wounds are commonly clear tracks, without much splintering of bone or laceration of tissues. The wound of entrance is extremely small and could be overlooked by a careless observer. It is usually circular, it may be triangular. The bullet is far less liable to lodge in the body than was the older bullet. If it perforates, the wound of exit is usually small,



Fig. 120.-Deformation of leaden bullets (natural size) (Seydel).

and may be either round or a slit. The wound of exit is large if the injury has been inflicted at close range, or if bone has been splintered and driven along with the bullet.

Theoretically, the projectile does not flatten, but it has been found that in many instances it does flatten a little. Its coat is apt to be torn off when it



Fig. 121.-Deformation of small-caliber jacketed bullets (after Bruns).

strikes hard bone at a distance of less than 1800 yards. Treves has pointed out that if a bullet smashes a bone and lodges, the shell, as a rule, peels off from the core. Then the bullet may be distorted or broken into fragments. At long range the bullet may lodge, or it may also do so if it hits a man after bounding from a stone, hard ground, or a piece of metal. It may lodge in



Fig. 122.—1, Empty Krag jacket removed from thigh after penetrating 5 inches at 140 yards; 2, 3, 4, 5, lodged Krag bullets removed from wounds after deflection from frozen ground. Ranges from 50 to 300 yards.

compact bone. In Cuba, 10 per cent. of the wounded suffered from lodged bullets. In the Russo-Japanese War less than 4 per cent. of the wounded suffered from lodged rifle bullets.

It is seldom that bits of clothing are carried in with the bullet, but sometimes they are, and some fabrics are more liable to be carried in than others. Threads are not unusually carried in on the roughened areas cut into the bullet by the grooves of the rifling. If the bullet ricochets from stony ground, bits of stone may enter the tissues.

Blood-vessels are likely to be cut and not pushed aside, as was often the case with the old-time bullets. If a large vessel is struck, primary hemorphage is profuse and may prove rapidly fatal. The modern bullet is seldom dedected in the tissues, but, as a rule, it passes straight ahead. The skin is usually split by it. Fascia and muscle are likely to be much damaged, but in a transverse wound of muscle the fibers may be separated rather than destroyed.

Although under most circumstances this bullet is humane, it has been found that in some instances it pulpifies structure for a considerable distance around the track of the ball, producing what is known as an explosive effect. The cause of this condition has been much debated, though it never means that the bullet has exploded. Some think that it is always due to comminution of bone and the blowing of bone-fragments ahead of and around the ball. Most believe that the sudden impact against the tissues engenders waves of force, which cause explosive and distant damage. Certain it is that an explosive effect causes horrible and often irreparable injury.

Explosive effects are most frequently seen at close range, when the velocity of translation and the frequency of rotation are most marked. Such injuries were seen in the marines killed at Guantanamo, in persons killed during the Milan riots, and in many instances in South Africa, China, and Manchuria.

A pistol bullet has no explosive action at all; and the old-time large, soft bullet possessed it only at a very close range. The modern projectile is apt to produce explosive effects up to 500 yards, but it does not invariably do so. Up to 1300 yards it is liable to produce them in the skull and brain; and at this distance a single bullet may entirely destroy the cranium. Explosive effects may at times occur at longer distances upon the liver, spleen, kidneys, and lungs, and upon hollow viscera containing fluid. At a distance of 500 yards or less a bone will usually be shattered into many fragments; whereas, at a range of 1500 or 2000 yards, the bone will, as a rule, be cleanly perforated, usually without comminution.

It is often extraordinary how little trouble follows a wound with a modern projectile and how quickly healing occurs. This is due to the facts that the tissue is cleanly perforated, that foreign bodies are seldom carried in, and that the wound rarely becomes infected. This freedom from infection is not due to the bullet being sterile. It is not sterile, and when the gun is fired the bullet does not heat sufficiently to certainly destroy bacteria. The bullet is carried in a dirty belt or pouch, is handled with dirty hands, and is not clean when put into the rifle, but its sides may be scraped cleaner by the riling and the burning powder may disinfect it in part. The point, however, contains bacteria on its surface. They are few in number; are readily scattered in the tissues; and, in most instances, are overcome by tissue resistance. The clean track of the bullet which is usual in wounds inflicted at ordinary fighting ranges impairs tissue resistance much less than a badly contused and lacerated wound. In some observed cases there have been almost no In others, none after perforation of the lung. In others, none after perforation of the abdomen, the joints, or skull. It is obvious that in most conflicts the

modern rifle is humane and that its humanity is largely a matter of range.

At a range of 1500 yards or over it is a humane weapon.

What used to be called a *wind contusion* is a severe and often a dreadful injury. The skin being unbroken, bones may be broken, viscera ruptured, tissues torn asunder. The older surgeons believed that such an injury was produced by the wind pressure, a projectile passing close to, but not touching the surface. We now know that they result from a projectile's glancing along the surface, the elasticity of the skin saving it from immediate destruction, although in many instances it sloughs later.

A bullet, in striking, never gets hot enough to burn a part. It is needless to

say that bullets are never deliberately poisoned.

Symptoms.—Pain is seldom severe in wounds of the soft parts, but violent, immediate pain is felt when a bone or a nerve is injured; the pain is usually stinging or burning, but is seldom of long duration, except in bone injuries, spinal cord injuries, and nerve injuries. Sometimes a man does not know he has been struck. It is common to have anesthesia or numbness and loss of muscle-function about the wound for several hours or days.

Shock is very variable. In some cases it is scarcely noticeable, in others it is overwhelming. It is most marked in wounds of bone, the spine, the abdomen, and the brain. It is greatly aggravated by hemorrhage. Hemorrhage is great if a large vessel is struck. If the vessel is in a limb it is seldom that much blood escapes externally, but a large hemorrhage occurs in the tissues. Such cases reach the hospital for treatment, and are spoken of as "traumatic aneurysm." They were quite common in South Africa. If a great vessel is divided in the chest or abdomen, the patient rapidly bleeds to death on the field,

and seldom reaches the hospital at all.

The bullet wound tends to remain uninfected unless bits of clothing or other foreign bodies have been carried in, unless the bullet was deformed, or unless the wound was at close range. If suppuration occurs, it is apt to remain localized. Pyemia and true septicemia are rare. In the Russo-Japanese War, suppuration seems to have been common. In the Japanese hospitals at least 60 per cent. of wounds of the soft parts by undeformed bullets suppurated. (Report on Russo-Japanese War, by Maj. Chas. Lynch, Medical Department, General Staff, U. S. A.) It is stated that among the Russians suppuration occurred in 30 per cent. of the cases. More wounds suppurated in winter than in summer. The Russians used a larger bullet than the Japanese, and the wound inflicted by the Russian bullet was far more liable to suppurate than was that produced by the Japanese projectile. Practically all wounds of bone made by Russian bullets suppurated. (Maj. Lynch, Ibid.)

Treatment.—The military surgeon is a specialist, and he must know many things besides the treatment of the sick and injured. He must be a master of hygiene; he must possess executive capacity; he must be able to disclipine others and to subject himself to discipline; he must be forceful, self-reliant, and resourceful; he must be acquainted with the laws and regulations of the military establishment; and he must have a special knowledge of gunshot-wounds as received in battle. Even the best qualified civil surgeon is unfit to pass into military service without special instruction. It is for this reason that the United States insists that every man appointed to the Medical

Cops of the Army or Navy shall receive special instruction in the Army Medical School or the Naval Medical School before he goes to a regiment or a ship. The wounds received in war are peculiar, and treatment appropriate for a wound inflicted by a revolver bullet is often inappropriate or impossible for a

wound inflicted by the projectile of a military rifle.

In civil life the patient has the best of surroundings. Every care can be given him. Numerous skilled assistants are at hand if needed. The problems of the case are entirely surgical, and the case can be dealt with purely according to its surgical necessities. In war there are problems of transportation which are not presented in civil life, for strategic necessity may compel hurried movement. Accommodations, also, may be bad. Shelter may be imperfect, climate and meterological conditions may be most trying. Food may be canty and inappropriate. Medicines may be scarce. There are sure to be too few assistants. After some engagements in South Africa the British surgeons had to care for numbers of men under difficulties that were appalling, among which were fearful clouds of dust and swarms of flies. In other words, the military surgeon, after a battle, is seldom able to treat his cases purely in accordance with surgical necessities, but his conduct must be influenced by other, often imperative, needs. If there are numerous wounded, he does not have time to do immediate laparotomies. He will lose some cases because he has not done laparotomy, but he would lose many more other cases from delay in treating dangerous but remedial conditions were he to make many simpler cases wait until his laparotomies had been performed. He is forced to make the abdominal wounds wait, and after long delay there is seldom any use in opening the abdomen at all.

Again, the wound inflicted by the bullet of a military rifle is very different in nature and in danger from the wound inflicted by a revolver bullet. In the former, if a large vessel is struck, it is perforated or divided, and profuse bleeding occurs, either into a cavity or in the tissues. If the bleeding occurs in a cavity, the patient usually dies on the field, and does not reach the first dressing-station at all. If it occurs in the tissues, a "traumatic aneurysm" forms. In revolver bullet wounds primary hemorrhage is seldom severe. Wounds with revolver bullets almost certainly suppurate. Wounds with the undeformed hard-jacketed projectile that has not richocheted very commonly escape infertion.

Wounds that in civil life might require only a resection, may in military practice require amputation. The promise of aseptic healing leads the military surgeon to trust many wounds without operation which in civil life would be operated upon at once, and both surgeons would be right in the different courses pursued by them.

In civil life the rule is absolute to open the abdomen for every case of purshot-wound entering that cavity. The experience of all military men is that more cases get well under a policy of non-interference than with laparotomy. In military surgery laparotomy can be performed only when there is time to do it"; and, even then, is performed only when there is hemorrhage or else certain evidence or a very strong probability that an organ or viscus has been struck or perforated. On account of the difficulties in the treatment of the wounded in military life, as compared with civil life, military surgery is a pure specialty; and the details of the treatment of wounds in war must be sought

for in treatises by military surgeons. The watchwords of the military surgeon are to preserve asepsis and to avoid meddlesome interference.

In handling patients in the field the clothing is cut away (if the wound is under the clothing). If sterile water can be obtained the wound and the surface about is irrigated with it before dressings are applied. If sterile water cannot be obtained the dressings are applied at once. The dressing should be absorbent and, if possible, antiseptic, rather than aseptic gauze. Absorbent cotton should be placed over the gauze, and a bandage of linen

should be applied to hold the dressing in place.

In warfare at the present day an attempt is made to limit the death-rate from gunshot-wounds by protecting them from infection at an early period after Esmarch offered a suggestion which has been adopted in the armies of all civilized countries. Every officer and private soldier carries a package which contains antiseptic dressings, and at the first opportunity after the infliction of a wound, if possible on the field, these dressings are applied by the soldier, by a comrade (for even the privates are instructed in the application), or by an ambulance man. If not applied on the field, they are applied at the first dressing-station by a surgeon or a hospital steward. The dressing is removed only when there are indications calling for surgical interference. Many wounds heal under this primary dressing. In the United States army the first-aid package is carried in a metal case to prevent contamination and damage by moisture. The case is hermetically sealed, but can be easily opened. It is carried hooked to the cartridge belt. It contains two bandages, two compresses of absorbent corrosive sublimate gauze, and two No. 3 safety-pins, all wrapped in waxed paper. One compress is stitched to the center of each bandage, and the bandage is so folded that the compresses can be opened without touching its inner surface. (In the foregoing article I have obtained facts from numerous sources. The following books and articles I found particularly serviceable: "Wounds in War," by Surgeon-General W. F. Stevenson, of the British Army; "Gunshot-wounds," by Major C. G. Spencer, of the British Army; "Military Surgery," by Surgeon-General Robert M. O'Reilly, U. S. A., in Vol. IV. of "Keen's Surgery"; "Naval Surgery," by Surgeon-General P. M. Rixey, U. S. N., in Vol. IV. of "Keen's Surgery"; Treves, in the "British Medical Journal," 1900; Senn, in "The Hispano-American War"; Makin, "Surgical Experiences in South Africa"; "Chirurgie de Guerre," Paris, 1897, by Constans; "Surgical Notes from the Military Hospitals in South Africa," by Dent; in the "British Medical Journal," 1900; "Gunshot-wounds," by Maj. Wm. C. Borden, U. S. A., in the "American Practice of Surgery," by Bryant and Buck, Vol. II.; "Delorme's Traite de Chirurgie de Guerre"; "Recent Reports of the Surgeon-General of the U. S. A."; the "Chitral Campaign," by H. C. Thomson; "Les Projectiles des Armes de Guerre," by Nimier and Laval; "Fifth Volume of the Proceedings of the Associations of Military Surgeons, U. S. A."; Follenfant, in "Archives de Medicine et de Pharmacie Militaire," July, 1906; "Reports of Military Observers in Manchuria during the Russo-Japanese War," by Maj. Charles Lynch, Medical Department, General Staff, U. S. A., 1907.) (For gunshot-wounds of special structures, see Bones, Joints, Abdomen, Brain, etc.)

Poisoned wounds are those into which some injurious substance, chemical or bacterial, was introduced. This poison may be microbic and capable

of self-multiplication, or it may be chemical, and hence incapable of multiplication. There are three classes of poisons:\* (1) mixed infection, as septic wounds, dissection-wounds, and malignant edema; (2) chemical poison, such as snake-bites and insect-stings; and (3) infection with such diseases

as rabies, glanders, etc.

Septic or infected wounds are those which putrefy, suppurate, or slough. Septic wounds should be opened freely to secure drainage, and hopelessly damaged tissue should be curetted or cut away. The wound should be washed with peroxid of hydrogen and then with corrosive sublimate, dusted with iodoform or orthoform, either drained with a tube or packed with iodoform gauze, and dressed with hot antiseptic fomentations. The part must be kept at rest and internal treatment should be stimulating and supporting. If lymphangitis arises, the skin over the inflamed vessels and glands is to be painted with iodin and smeared with ichthyol, and quinin, iron, and whisky are given internally. The temperature is watched for evidence of general infection or intoxication. The patient must be stimulated freely, nourishing food is given at frequent intervals, pain is allayed by anodynes if necessary, and sleep is secured. In infected wounds of the extremities Bier's treatment is very useful.

Dissection=wounds are simple examples of infected wounds, and they present nothing peculiar except virulence. They affect butchers, cooks, surgeons who cut themselves while operating on infected areas, those who make post-mortems, and those who dissect. A dissection-wound inflicted while working on a body injected with chlorid of zinc possesses but few elements of danger unless the health of the student is much broken down. If a wound is simply poisoned with putrefactive organisms, there is rarely serious trouble. Post-mortems are peculiarly dangerous when the subject has died of some septic process. When a wound is inflicted while dissecting, wash it under a strong stream of water, squeeze, and suck it to make the blood run, lay it open if it be a puncture, paint it with pure carbolic acid, and dress it with iodoform and hot antiseptic fomentations. Trouble, of course, may follow, but often it is only local, and a small abscess forms. It should be treated by hot antiseptic fomentations and early incision. Occasionally lymphangitis arises, adjacent glands inflame, and constitutional symptoms arise. It is rarely that true septicemia or pyemia arises unless the wound was inflicted while making a post-mortem upon a person dead of septicemia of while operating on a septic focus. If glands enlarge and soften, it may be necessary to remove them surgically.

Malignant edema or gangrenous emphysema arises most commonly after a puncture. It is due to a specific bacillus which produces great edema. The emphysema which soon arises is due to mixed infection with putrefactive organisms. Pus does not form, but gangrene occurs. The disease is identical

with one form of traumatic spreading gangrene (page 185).

Symptoms.—The symptoms are identical with those of traumatic spread-

ing gangrene with emphysema.

There is a rapidly spreading edema, followed by gaseous distention of the tissues and by gangrenous cellulitis. The zone of edema is at the margin of the emphysema, and the process spreads rapidly. The emphysematous zone

<sup>\* &</sup>quot;American Text-Book of Surgery."

crackles when pressed upon. The area of edema is covered with blebs which contain thin, putrid, reddish matter, and the skin becomes mottled. If a wound exists, the discharge will be bloody and foul. If incisions are made, a thin, brown, offensive liquid flows out. High fever rapidly develops, the patient becomes delirious, and often coma arises. In most cases death ensues in from twenty-four to forty-eight hours.

Treatment.—If malignant edema affects a limb after a severe injury amputate at once, high up. If it affects some other part or begins in a limb after a trivial injury, make free incisions, employ hot, continuous antiseptic irrigations or the hot antiseptic bath, and stimulate freely (page 186).

Stings and Bites of Insects and Reptiles: Stings of Bees and Wasps.—A bee's sting consists of two long lances within a sheath with which a poison-bag is connected. The wound is made first by the sheath, the poison then passes in, and the two barbed or twisted lances, moving up and down, deepen the cut. The barbs on the lances make it difficult to rapidly withdraw the sting, which may be broken off and remain in the flesh. Besides bees, hornets, yellow jackets, and other wasps produce painful stings. The sting of a wasp is rarely broken off in the tissues because the beards on the darts are shorter and hence the sting is not so firmly fixed in the flesh, and also because these insects are more rapid and nimble in their actions. Stings of bees and wasps rarely cause any trouble except pain and swelling. In some unusual cases a bee-sting is fatal; persons have been stung to death by a great number of these insects. If a tick bites a person he clings to his victim. If an attempt is made to pull it off his barb remains in the tissues and an abscess follows. If a drop of ammonia is placed upon the tick he will at once withdraw his barb. A tick bite never causes constitutional disturbance.

Symptoms.—If general symptoms ensue, they appear rapidly, and consist of great prostration, vomiting, purging, and delirium or unconsciousness. These symptoms may disappear in a short time, or they may end in death from heart-failure. Stings of the mouth may cause edema of the glottis.

Treatment.—To treat a bee-sting, extract the sting with splinter forceps if it has been broken off and is visible in the wound. If it is not visible, squeeze the part lightly in order to expel it, or at least expel the poison. Pressure may be most satisfactorily made by means of the barrel of a key. The poison is counteracted by touching with ammonia or washing the part in ammonia-water, touching with pure carbolic acid, painting with tincture of iodin, or soaking in a strong solution of common salt or carbonate of sodium. The part may be dressed with lead-water and laudanum, a solution of washing-soda, or a solution of common salt. If constitutional symptoms appear, stimulate.

Other Insect-bites and Stings.—The mandibles of a poisonous spider are terminated by a movable hook which has an opening for the emission of poison. The bite of large spiders is productive of inflammation, swelling, weakness, and even death. The bite of the poisonous spider of New Zealand produces a large white swelling and great prostration; death may ensue, or the victim may remain in a depressed, enfeebled state for weeks or even for months. The tarantula is a much-dreaded spider. The scorpion has in its tail a sting. The sting of the scorpion produces great prostration, delirium, vomiting, diaphoresis, vertigo, headache, local swelling, and burning pain,

followed often by fever and suppuration, and occasionally even by gangrene, but it is rarely fatal. *Centipedes* must be of large size to be formidable to man, and the symptoms arising from their stings are usually only local.

Treatment.—Tie a fillet above the bitten point; make a crucial incision, favor bleeding, and paint the wound with pure carbolic acid or some caustic or antiseptic (if in the wilds, burn with fire or gunpowder); dress antiseptically if possible, and stimulate as constitutional symptoms appear. Slowly loosen the ligature after symptoms disappear. Chloroform stupes and ipecac poultices are recommended; also puncture with a needle and rubbing in a mix-

ture of 3 parts of alcohol and 1 part of camphor (Bauerjie).

Snake=bites.—The poisonous snakes of America comprise the copperheads (red vipers or upland moccasins), water moccasins (rice snakes or cottonmouths), and rattlesnakes. The cobra of India is a deadly reptile. In some countries great numbers of people and the lower animals are killed by poisonous serpents. In India during 1898, 21,921 persons and at least 80,000 cattle were killed by snakes ("Brit. Med. Jour.," Nov. 25, 1899). It used to be taught that there is no essential difference in the action of venoms of different varieties of snakes, and that the venom of an Indian cobra is practically identical with the venom of an American rattler, any apparent difference in action depending upon difference in toxic power and the different dose of poison introduced. We now know that there are essential differences in venoms (Leonard Rogers in "Lancet," Feb. 6, 1904). , The natural toxic power of the poison varies in different species and also in different members of the same species. Poison injected into a vein may prove almost instantly fatal. The poison is not absorbed by the sound mucous membranes. Poison is harmless when given by the mouth and swallowed, but if directly introduced into the intestine of an animal it is certainly fatal. The pancreatic ferment destroys the toxic power of the venom (R. H. Elliot, in "Brit. Med. Jour.," May 12, 1900). The venom is discharged through the channeled fangs of the reptile, having been forced out by contractions of the muscles of the poison-bag. In most varieties of snakes the teeth lie along the back of the mouth and are only erected when the reptile strikes. The maxillary bones of the rattlesnake are very short and move with great freedom at the prefrontal articulation. The fangs are attached to the maxillary bones and move with the bones. The fangs, when depressed, are carried in a fold of mucous membrane. When the animal is ready to strike the langs are erected into a vertical position and carried to the front of the mouth. Cope describes the movement used by the rattlesnake in biting. The body unings forward, but never more than two-thirds of the reptile's length, the jaws size the tissues and then the fangs penetrate and move to and fro as the poison emerges from them. Snake-poison is a thin, greenish-yellow, turbid, sterile find, of acid reaction and of a distinctive odor. The two chief poisonous principles are called venom-peptone and venom-globulin (Gustave Langmann, "Medical Record," Sept. 15, 1900).

Symptoms.—Rogers ("Lancet," Feb. 6, 1904) divides poisonous snakes into two classes: the *colubrines* (of which the cobra is an example) and the riperines, which are not so poisonous (this class includes rattlesnakes and puff adders). Colubrine venom, according to this observer, causes paralysis of the respiratory center and of the motor end organs of the phrenic nerves, destruction of red blood-corpuscles, lessened coagulability of blood, and death

by respiratory paralysis. Viperine venom causes paralysis of the vasomotor center, great destruction of red corpuscles, some viperine venoms may cause thrombosis, and death from any one of them is due to vasomotor The venom of some snakes, Rogers says, contains a mixture of the above-mentioned venoms (among such snakes are the Australian colubrines and the American pit-adders). The mortality from snake-bites varies. The mortality in India from cobra bites is about 25 per cent. (Sir Joseph Fayrer). The mortality in America from rattlesnake bites is about the same. The local symptoms are: pain, soon becoming intense; mottled swelling of the bitten part, which swelling may be enormous, and which is due to edema and extravasation of blood, and assumes a purpuric discoloration. The bite of a cobra produces inflammation and marked spreading edema. It may be recovered from without symptoms or with trivial symptoms it may induce profound systemic involvement. The general symptoms begin in a comparatively few minutes. The coagulating power of the blood is lost, there is great destruction of red corpuscles. The patient is terror-stricken and soon becomes unable to stand because of weakness of the legs. Glosso-laryngeal paralysis arises, and talking and swallowing become impossible. There is a profuse flow of saliva, perhaps nausea and vomiting. The patient may be dull mentally but is not unconscious. The paralysis becomes widespread, and finally the diaphragm and respiratory center become involved, and death occurs from respiratory paralysis. Artificial respiration may prolong life for hours (Sir Joseph Fayrer). Bad cases usually die in three or four hours, but life may last for many hours. A rattlesnake bite produces severe pain and mottled swelling from blood extravasation. In some cases there is enormous swelling from edema and blood: the discoloration in such a case is purpuric. The blood of the victim quickly undergoes hemolysis and loses the power of coagulation. It was previously stated that in laboratory experiments it has been shown that viperine poison may produce thrombosis, but it does not do so in man, as it contains a very small amount of the coagulating element (Rogers). Extravasations of blood occur in serous and mucous membranes and in the skin, petechial spots frequently arising upon the cutaneous surface. There may be free bleeding from mucous surfaces and great extravasation beneath the conjunctivæ. These blood extravasations are due, according to Flexner, to destruction of vascular endothelium. General symptoms begin in from a few minutes to several hours. The symptoms are those of profound shock, possibly with delirium, the vaso-motor center being exhausted and finally paralyzed. There is usually muscular twitching, convulsions, and finally paralyses are noted in most cases (pharyngeal palsy, paraplegia, and ascending paralysis). There may be complete consciousness, or there may be lethargy, stupor, or coma. Death may occur in about five hours, but, as a rule, it is postponed for a number of hours. If death is deferred for a day or more, profound sepsis comes upon the scene, with glandular enlargement, suppuration, and sometimes gangrene.

Treatment.—Cases of snake-bite must, as a rule, be treated without proper appliances. The elder Gross was accustomed to relate in his lectures how he had seen an army officer blow off his finger with a pistol the moment after it was bitten by a rattlesnake, and thus escape poisoning. In general, the rules are to twist several fillets at different levels above the bite, to excise

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the bitten area, to suck or cup it if possible, and to cauterize it with pure acid or by heat. An expedient among hunters is to cauterize by pouring a very little gunpowder on the excised area and applying a spark, or by laying a hot ember on the wound. When a hot iron is available, use it. The fillets are not to be removed suddenly, and they had best be kept on for some time. Remove the highest constricting band first; if no symptoms come on after a time, remove the next, and so on; if symptoms appear, reapply the fillet. Some surgeons inject in many places about the wound a few drops of a 10 per cent. watery solution of chlorid of calcium. It is taught by others that if a man is bitten by a large and deadly snake, the surgeon, if one is at hand, should at once amputate well above the bite.\* Wynter Blyth pointed out that permanganate of potassium mixed with an equal weight of cobra venom renders the venom inert. A number of surgeons have treated snake bites by injecting in and about the wound a 1 per cent. solution of permanganate of potassium, but this plan is inefficient. Rogers ("Lancet," Feb. 6, 1904) says we should tie a fillet around the limb above the bitten part, take a knife and enlarge the wound and rub in crystals of permanganate. Whatever local treatment is employed stimulants are to be given and large doses of alcohol are very generally relied upon. Some give strychnin hypodermatically, others ether, others digitalis. Halford, of Australia, advocated the intravenous injection of ammonia (10 m of strong ammonia in 20 m of water). Adrenalin as given in shock, is indicated if the vaso-motor center is becoming paralyzed, and auto-transfusion and external heat are also indicated. If the respiration is failing artificial respiration and oxygen inhalation are required. Attempts are being made to obtain a curative serum. Animals can be rendered immune by giving them at first small doses of the poison and gradually increasing the amount administered. It is asserted that the serum of immune animals will cure a person bitten by a venomous snake. Cures have been reported after the use of Calmette's antivenene serum. Antivenene is obtained by immunizing a horse by injecting attenuated venom. The mixture to be attenuated consists of 80 parts of cobra venom and 20 parts of viperine venom. It takes a number of months to obtain strong antivenene. The dose is from 10 to 20 cc. hypodermatically, repeated if necessary in three or four hours. It seems certain, however, that no single serum can antidote the venom of all varieties of expents (A. T. F. Macdonald, of Australia), and it has been shown that, though Calmette's antivenene is antagonistic to colubrine venom, it is inert against viperine venom. Again, as Rogers says, it deteriorates quickly in hot climates and is seldom on hand when wanted. The horse can be immunland against rattlesnake venom, and antivenene obtained from the horse may be sed against rattlesnake poison.

The poisonous lizard (Gila monster) can kill small animals, but it

B not believed that its bite is ever fatal to man.

Anthrax (Malignant Pustule, Charbon, Wool-sorters' Disease, Milzbrand, or Splenic Fever) is a term used by some as synonymous with onlinary carbuncle, but it is not here so employed. It is a specific contagious disease resulting from infection with the bacillus of anthrax. Animal anthrax is particularly common in the East and in Russia, and is frequently met with in Germany, Italy, and South America. In some regions so many cases

<sup>\*</sup> Charters James Symonds in "Heath's Dictionary of Practical Surgery."

arise year after year that the district obtains an evil notoriety. It is stated that in Novgorod, Russia, in four years, "56,000 horses, cattle and sheep, and 528 men perished from anthrax" (Frank S. Billings, in "Twentieth Century Practice"). It is a rare disease in the United States. In Philadelphia cases occasionally occur in workers in the woolen mills. The author has seen three cases of human anthrax, two of which occurred in Philadelphia and one in New Jersey. Herbivora are most liable, next omnivora, but carnivora seldom suffer. Anthrax, as met with in man, is a disease contracted in some manner from an animal with splenic fever.



Fig. 123.—Anthrax. Case in author's wards in Philadelphia Hospital, recovered. Treated by ipecac both externally and internally.

It may be contracted by inoculation by working around diseased animals, by handling or tanning their hides, or by sorting their hair or wool: brush-makers, spinners, workers in horn and combers, rag sorters, veterinary surgeons, clippers, stockmen, farmers, and butchers may become inoculated. Infection may take place through the hair follicles of unbroken skin. Menschig reported two such cases ("N. Y. Med. Jour.," Nov. 18, 1905). Anthrax may be conveyed by eating infected meat or by drinking infected milk. Flies may carry the poison. Inhalation of poisoned dust may infect the lungs. Catgut ligatures may be contaminated and carry the poison. Many attempts, not altogether satisfactory, have been made to render animals immune (Pasteur, Woolbridge, Hankin). Pasteur's method has been used in France with de-

cided success, but with less success in other countries. Certain organisms are antagonistic to anthrax (the streptococcus of erysipelas, the pneumococcus, the micrococcus prodigiosus, and the bacillus pyocyaneus).

Forms of Anthrax.—There are two forms of the disease—external and internal. Internal anthrax may be intestinal from eating diseased meat or pulmonary from inhalation of poisoned dust. Intestinal anthrax arises only when the bacilli in the meat contain spores. Koch and others have pointed out that the non-sporulating bacteria are destroyed by the gastric juice. External anthrax may be anthrax carbuncle or anthrax edema. Anthrax carbuncle or malignant pustule appears on an exposed portion of the body, especially the hand or fingers, in over 80 per cent. of cases of external anthrax. I saw one upon the temple. It appears in from twenty-four hours to six days after inoculation, and presents an itching, burning papule with a purple center and a red base; in a few hours the papule becomes a vesicle which contains bloody serum and the tissues about the papule become swollen, reddened, and

indurated. The vesicle bursts and dries, the base of it swells and enlarges, other vesicles appear in circles around it, and there is developed an "anthrax carbuncle," which shows a black or purple elevation with a central depression surrounded by one or more rings of vesicles. The surrounding tissues become purple, and great edema may spread widely, the vesicles grow very large and new vesicles form, and gangrene may occur. Pain is trivial or absent. Lymphatic enlargements occur but pus does not form. Within forty-eight hours after the pustule begins micro-organisms usually appear in the blood. The constitutional symptoms may rapidly follow the local lesion, but may be delerred for a week or more. The patient feels depressed, has obscure aches and pains, and is feverish, but usually keeps about for a short period. After a time he is apt to develop rigors, high irregular fevers, sweats, acute fugitive pains, diarrhea, delirium, typhoid exhaustion, dyspnea, cough, and cyanosis. The carbuncle of anthrax is distinguished from ordinary carbuncle by the central depression, the adherent eschar, the absence of pain, tenderness, and suppuration of the first, as contrasted with the elevated center, the multiple foci of suppuration and sloughing, and the more severe pain usual in the second. If anthrax has a visible lesion and the constitutional symptoms are slight or absent the chance of cure is good. In cases which get well a line of demarcation forms about the pustule and the gangrenous area is rather rapidly cast off, a granulating surface remaining.

Anthrax Edema.—An area of edema surrounds a malignant pustule and often spreads widely, but in cases of external anthrax without a pustule there is edema alone. This lesion occurs in connective tissue, especially loose fissue. It is a spreading, livid edema, with an ill-defined margin. There is no pain and usually no vesication and no fever. In severe cases, however, there is fever, vesicles form, and gangrene may arise. Anthrax edema differs from cellulitis in the absence of pus formation, and from malignant edema by the less disposition to result in gangrene. Two of the cases I have seen were anthrax edema. In Horwitz's case in the Philadelphia Hospital the forearm, arm, and shoulder were enormously edematous. In Keen's case in the Jefferson College Hospital the forearm and arm were edematous.

Prognosis.—The former estimate of the death-rate from external anthrax was from 25 to 30 per cent. If upon the face the prognosis is much worse than if upon the extremities, and if upon the upper extremity worse than if upon the lower. It is claimed that the death-rate has been notably reduced by modern treatment, and under serum treatment is said to be but little over 6 per cent. In a series of 15 cases of external anthrax reported by Royer and Holmes there were 3 deaths ("Therapeutic Gazette," Jan., 1908). Eleven of these cases received serum and of the eleven two died.

Pulmonary anthrax and intestinal anthrax have been regarded as in-

rariably fatal, but vastly better results may be looked for hereafter.

Treatment of External Anthrax.—If a person is wounded by an object tappeted of carrying the infection, cauterize the wound with the hot iron. A sufferer from anthrax must be isolated in a well-ventilated room. All dressings are to be burned, all discharges asepticized, and after the removal of the patient the bed-clothes are burned and the room disinfected. A malignant pustule should be entirely excised, and the wound mopped out with pure carbolic acid or burned with the hot iron. If there is an extensive area of

edema it should be freely incised at several points. The area about the excised pustule should be injected with a 5 per cent, solution of carbolic acid. The wound and the edematous area should be dressed with hot antiseptic fomentations, and, if dealing with an extremity, a splint is applied. Excision should be practiced even when glands are enlarged, but it will prove ineffectual, as a rule, if organisms are present in the blood. When excision cannot be performed make crucial incisions through the lesion, mop the wounds with pure carbolic acid, and inject about and in the pustule carbolic acid (1:20) every six hours until the disease abates or toxic symptoms appear. Dress the part as directed above. In a successful case the adherent eschar is finally separated by the influence of the fomentations. Davaine advised the following plan: Inject the pustule and the tissues about it at many points every eight or ten hours with I part of tincture of iodin diluted with 2 parts of water or with a 10 per cent, solution of carbolic acid. or with a o.1 per cent, solution of corrosive sublimate. Dress with wet antiseptic gauze and apply an ice-bag. Personally I would not use an ice-bag on an area of infection but would prefer heat. In anthrax edema inject a 5 per cent. solution of carbolic acid into the apparently sound skin and subcutaneous tissue just above the margin of the edema and repeat the injections every six hours. Make free multiple incisions in the edematous area carrying each incision down to the deep fascia. Dress with hot antiseptic fomentations and if dealing with a limb apply a splint. In Keen's very severe case of anthrax edema, this treatment was carried out by George I. Schwartz and recovery followed. Constitutional treatment in anthrax edema or malignant pustule must be sustaining and stimulating. Maffucci gives carbolic acid internally, and also uses it externally. Davies-Colley uses ipecac locally and gives gr. v by the mouth every four hours. Statistics indicate that the serum treatment is of the greatest value. The material is known as Sclavo's serum; it is obtained from the immunized ass, and it was introduced into practice in 1897. It is perfectly harmless and may be given in a vein or subcutaneously. Sclavo injects 40 cc. in different regions of the wall of the abdomen. If improvement is not obvious in twenty-four hours the dose is repeated. Intravenous injection is reserved for severe cases, the dose being 10 cc. into a subcutaneous vein of the dorsal surface of the hand. The serum can do no harm and should always be given. If given early, all cases but very severe ones will recover (Legge's Nilray Lectures, "Brit. Med. Jour.," March 18, 1905). The persistence of anthrax infection in a room was well shown in the record of Keen's case. The infection lingered on the floor of the room in which the patient had been operated upon for a long time. Three disinfections were necessary before it became impossible to obtain anthrax bacilli from the contaminated floor. This indicates that such a case should be operated upon in a room not regularly used for operations.

Hydrophobia, Rabies of Lyssa.—Hydrophobia is a spasmodic and paralytic disease due to inoculation with the virus from a rabid animal. Inoculation is nearly always through a wound, but cases occur after the licking of the hand by a diseased dog. The disease does not appear to arise except as the result of inoculation. It is most common in dogs and wolves, but it may develop in cats, horses, goats, foxes, cattle, sheep, and pigs. It is far more common in the carnivora than the herbivora. It is said that poultry may suffer from it. Human hydrophobia in most instances follows dog bites.

Roux estimates that about 14 per cent. of the people bitten by mad animals develop the disease. If the bite is on an exposed part, it is far more apt to cause rabies than if the rabid animal's teeth passed through clothing. The saliva is the usual vehicle of contagion, but other fluids and tissues contain the virus, especially the brain and cord. The blood and urine do not contain it. Hydrophobia has been known for centuries. It is not spoken of by Hippocrates, but is described by Aristotle, Pliny, and Celsus, and is alluded to by Plutarch. At the present day some ardent antivivisectionists dispute its existence. The fact that an infant bitten by a rabid animal may develop rabies proves that the disease is not due to the imagination. Hydrophobia is almost invariably fatal. No causative micro-organism has been demonstrated. One must exist, but it probably escapes detection because of its very small size. Negri has discovered in the central nervous system bodies which are probably protozoa and are perhaps the cause of the disease. They are called Negri bodies. The poison cannot gain entrance through sound mucous membrane. It used to be thought that the disease was particularly apt to arise in hot weather, but it is now known that it may occur any time of the year. There was a veritable epidemic of it among the animals in Greenland in 1860 and at this time the temperature averaged 25 degrees below zero (F. W. Dudley, in "Jour. Am. Med. Assoc.," Dec. 19, 1908). It is common in Russia. No portion of the world is completely exempt. No constant post-mortem lesions have been certainly demonstrated in those dead of rabies. Gowers believes that in the spinal cord there is hyperemia, but no infiltration with cells, whereas in the medulla, especially about the respiratory center, there are hyperemia and celluhr infiltration of the perivascular spaces. But such perivascular infiltration can occur in some other acute conditions and hence is not characteristic. What is known as the rabic tubercle is found in the medulla and about the motor cells of the upper part of the spinal cord. Each tubercle consists of an aggregation of embryonal cells, which destroy and finally replace the nerve-cells which they surround. Babés thinks the tubercle characteristic. Infiltration of the ganglia with epithelioid cells and round cells has been held by some to be characteristic, but both the rabic tubercle and ganglion infiltration occur in other conditions. The disease is extremely rare in the United States and the author has never seen a single case.

Il a dog is poisoned with barium carbonate the symptoms are similar to

these of rabies (see Univ. of Penna. Health Bulletin, Aug., 1909).

Symptoms.—The period of incubation of human hydrophobia is from a few weeks to several months, and it has been alleged that it may even be two pears, but it is very doubtful if there is ever a period of incubation of over six or seven months. The average incubation period in man is forty days (Ravenel). The initial symptoms are mental depression, anxiety, sleeplessness, restlessness, headache, malaise, and often pain or even congestion in the cicatrix. The anxiety which is usually present may be deepened into actual fear. In dogs the condition of fear is so evident that Cælius Aurelianus centuries ago called the disease pantophobia (fear of everything). The previously-mentioned symptoms are quickly followed by dysphagia. It is not only water that is difficult to swallow but everything the patient tries to drink or eat. The difficulty in swallowing results apparently from appear produced instantly when an attempt is made to swallow. Curtis points out that the difficulty is not spasm of the pharynx and larynx, but

a sense of immediate suffocation due to reflex stimulation of respiratory inhibition. If spasms occur-and they may occur-they are secondary to this suffocative state, a state in which the action of the diaphragm ceases for a time. The air-passages become congested and the sufferer makes frequent and painful efforts to expel thick mucus, and the efforts produce paroxysms of suffocation. Between the paroxysms the patient is evidently somewhat breathless, and Warren tells us that his speech is not unlike that "of a child who has recently been crying and is endeavoring to control itself" ("Surgical Pathology and Therapeutics"). As the condition grows worse, suffocative attacks, which were at first induced by attempts at swallowing, come to be caused also by bright lights, sudden or loud noises, irritations of the skin, or even thinking of swallowing. At length suffocative paroxysms occur spontaneously and the patient jumps, or hurls himself about, or the muscles of the entire body are thrown into clonic spasm. Tonic spasm does not occur. A condition of general hyperesthesia exists. The mind is usually clear, although during the periods of excitement there may be maniacal furor with hallucinations which pass away in the stage of relaxation. The temperature is moderately elevated (101° to 103° F. or higher). The spasmodic stage lasts from one to three days, and the patient may die during this stage from exhaustion or from asphyxia. If he lives through this period, the convulsions gradually cease, the power of swallowing returns, and the patient succumbs to exhaustion in less than twenty-four hours, or he develops ascending paralysis which soon causes cardiac and respiratory failure. In what is known as paralytic rabies, a very rare form of the disease in human beings, the attack comes on with the same early symptoms met with in the commoner form, but paralysis soon begins about the bitten part and spreads to all the limbs and to the trunk.

In hydrophobia death is almost inevitable. Practically all cases in which it is alleged that recovery ensued were not true hydrophobia, but hysteria. An exception must be made of Murri's case. Wood says that in hysteria, especially among boys, "beast-mimicry" is common, the sufferer snarling like a dog; and in the form known as "spurious hydrophobia," in which there may or may not be convulsions, there are a dread of water, emotional excitement, snarling, and attempts to bite the bystanders (in genuine hydrophobia no attempts are made to bite, and no sounds are uttered like those made by a dog).

Lyssa is separated from lockjaw by the paroxysms of suffocation and the absence of tonic spasms in the former, as contrasted with the fixation of the

jaws and the tonic spasms with clonic exacerbations of lockjaw.

Treatment.—When a person is bitten by a supposed rabid animal and is seen soon after the injury, constriction should be applied if possible above the wound, the wounded area should be excised, cauterized with pure nitric acid, a hot iron or the Paquelin cautery, and dressed antiseptically. If the patient is not seen for a number of hours or a day or two after the injury, cauterization is useless; it is not only useless, but it may delude the patient and his friends into a feeling of security. In any case, send the patient at once to a Pasteur institute. If the animal which inflicted the injury was not hydrophobic, no harm will result from inoculations; if it was hydrophobic, preventive treatment may save the patient. The method known as the pre-

ventive treatment was devised by Pasteur, who discovered the following remarkable facts: If the virus of a rabid dog (street rabies) be placed beneath the dura of another dog, it always causes hydrophobia in from sixteen to twenty days, and invariably causes death. If the virus is passed through a series of rabbits it gets stronger (laboratory virus), and if inserted beneath the dura of a dog it causes the disease in from five to six days, and kills in four or five days. The virus can be attenuated by passing it through a series of monkeys or by keeping it for a definite time. To obtain attenuated preparations in a convenient form Pasteur made emulsions from the spinal cords of hydrophobic tabbits, the animals having been dead two or three weeks. He found that the emulsion obtained from the rabbit longest dead is the weakest. He injected a dog with emulsions of progressively increasing strength and made it immune to hydrophobia. The patient is injected with an emulsion made from the dried spinal cords of hydrophobic rabbits. In this emulsion the virus is attenuated, and day by day the strength of the injected virus is increased. These emulsions cause the body-cells to form antitoxin, and either the virus of street mbies does not develop at all or by the time it begins to develop a quantity of antitoxin is present to antagonize it. In the New York Pasteur Institute patients remain under treatment for fifteen days, two inoculations being given daily. In cases in which treatment is begun late, or in which the head or face was bitten, from four to six inoculations are given each day. The report of the Parisian Pasteur Institute shows that since its foundation there has been a mortality of 0.5 per cent. The lowest estimated number of those attacked by hydrophobia before this method was used was 5 per cent, of those bitten, and all attacked died; hence, the Pasteur treatment as applied in the Parisian Institute shows one-twenty-fifth of the mortality which attends other preventive methods. Ravenel, in 1901, estimated that 55,000 persons have been treated by the Pasteur method and that less than 1 per cent. have died. The value of this plan seems definitely established. The general public believes that the dog which did the biting should be killed. The dog should, if possible, be locked up and watched rather than killed. It may be proved in this way that it did not have hydrophobia. If it were necessary to kill the dog, or if the dog was killed at once or soon after, the physicians of the New York Pasteur Institute advise that the dog's head be cut from the body with an Beptic knife and a piece of the medulla oblongata be abstracted. The bit of medulla should be placed in a mixture of equal parts of glycerin and water which was previously sterilized by boiling. The bottle should be sealed and sent to the institute, in order that inoculations may be made upon animals to hove the existence or absence of hydrophobia. Babés tubercles and Negri's lodies are at once sought for in the specimen, and if they are found, treatment should be started at once. In the paroxysm of hydrophobia the treatment in the past was purely palliative. If we employ only palliative methods, keep the patient in a dark, quiet room, relieve thirst by enemata, saturate him with morphin, empty the bowels by enemata, attend to the bladder by regular atheterization, and during the paroxysms anesthetize. Murri, of Bologna, fured a case of hydrophobia by injecting emulsions of cords of rabibts dead six, five, four, and three days respectively. It would be proper to try this temedy if hydrophobia develops. A serum has been prepared by Tizzoni and Centani which they claim is successful in treating the disease as experimentally

induced in the laboratory. The remarkable suggestion has come from Tizzoni that rabies be treated with rays of radium, it having been shown that rabic virus can be destroyed by radium.

Glanders, Malleus, Farcy, or Equinia.—Glanders is an infectious eruptive fever occurring in horses, asses, goats, hogs, cats, and some other animals, and communicable to man. Cattle, house mice, white mice, and white rats are immune. Human glanders is by no means as uncommon as was once thought. Not a few cases die undiagnosticated. In a recent study 156 cases were discussed (Robin, "Studies from the Royal Victoria Hospital of Montreal," 1906). If the nodules occur in the nares, the disease is called "glanders"; if beneath the skin, it is termed "farcy." This disease is due to the bacillus mallei and is communicated to man through an abraded surface or a mucous membrane. Bernstein and Carling reported 6 cases of human glanders. They say: "In none of our cases was there definite evidence of the point of inoculation or path of infection, and the general evidence, clinical and experimental, in both these questions is so conflicting that the time is hardly ripe for the expression of decided opinions. The hypothetical paths are by direct inoculation through a wound or by the hair follicles, by inhalation or by ingestion ("Brit. Med. Jour.," Feb. 6, 1909). The characteristic lesions are infective granulomata in the nares, skin, lungs, and subcutaneous tissue. In the nares granulomata result in ulcers and under the skin break down into abscesses. From the site of inoculation the bacilli are disseminated and the cutaneous and muscular structures and lungs become involved. The disease is most common in the horse, but occurs also in the ass, mule, cat, rabbit, goat, and other animals. Man can be infected from a diseased animal, and as the common source of infection is the horse, the usual victims are those who use or work about horses. The period of incubation after infection is four or five days.

Acute and Chronic Glanders. - In acute glanders there is septic inflammation at the point of inoculation; nodules may form in the nose and ulcerate; there is profuse nasal discharge; the glands of the neck enlarge; there is weakness, frontal headache, chilliness, pain in the back and limbs; often diarrhea; after a time the muscles become painful; there is fever, the evening temperature being 100° F. or higher, and the morning temperature being lower. Chills may occur. There may be chest pains, severe muscular pain, bronchitis, and signs of pulmonary congestion. The lungs may be infected by inspiration of the bacilli in the discharge of the ulcers. It may not be suspected that the patient has glanders and the diagnosis of typhoid may perhaps be made. Twelve to fourteen days after the beginning of the trouble little hard lumps arise in the muscles and just beneath the skin. In a few days the lumps soften, break down, and discharge a bloody fluid which contains the bacilli of glanders. In a number of cases an eruption resembling smallpox appears on the face and about the joints, and this exanthem is usually prophetic of approaching death. It differs from smallpox in not being umbilicated. Leukocytosis may or may not exist. Acute glanders is nearly always fatal. Chronic glanders lasts for months, is rarely diagnosticated, being mistaken for catarrh, is often recovered from, but if uncured will sooner or later eventuate in a fatal acute condition.

Acute and Chronic Farcy.—Acute farcy arises at the site of a skininoculation; it begins as an intense inflammation, from which emerge inflamed lymphatics that present nodules or "farcy-buds." Abscesses form, but the pus differs in appearance from ordinary pus, is often gelatinous, and may be red in color. There are joint-pains and the constitutional symptoms of sepsis, but no involvement of the nares. In it nodules occur upon the extremities, which nodules break down into abscesses and eventuate in ulcers resembling those of tuberculosis or, perhaps, of syphilis. The ulcers form rapidly and often heal.

Diagnosis of Glanders and Farcy.—Injection of mallein may produce a significant reaction (fever, malaise, restlessness, perhaps a distinct rigor, sometimes vomiting). The dose used is 10 to 15 minims (Bernstein and Carling, in "Brit, Med. Jour.," Feb. 6, 1909).

Mallein is prepared from cultures of the bacilli of glanders, it has proved valuable in the hands of veterinarians, and it produces a reaction when injected into an animal with glanders like the reaction produced by tuberculin on a tuberculous animal.

Animal injection is valuable in diagnosis. The highly susceptible guineapig is used for this purpose. The doubtful material (nasal mucus or pus or a tissue fragment) is injected into the peritoneal sac of a male guinea-pig. In three to four days the testicles enlarge and later suppurate.

The pig is killed and the pus examined for the bacillus of glanders. Testicular enlargement does not always occur even when the inoculated material was from a lesion of glanders. In some cases it does not occur for weeks. As a rule, it does occur.

In the lesions of glanders the bacilli of the disease are scanty and in many lesions are mingled with other bacteria, hence the bacteriological diagnosis is always difficult and is often impossible without animal inoculation. The value of an aggultination test is as yet undetermined.

Treatment.—In treating this disease the point of infection is at once to be incised and cauterized, dusted with iodoform, and dressed antiseptically. The skin over enlarged glands and swollen lymphatics is to be painted with willin and smeared with ichthyol. Bandages are applied to edematous extremties. Ulcers are curetted, touched with pure carbolic acid, dusted with iodoform, and dressed antiseptically. In glanders the nostrils should be sprayed at frequent intervals with peroxid of hydrogen and syringed with a solution of sulphurous acid. The mouth must be rinsed repeatedly with solutions of thlorate of potassium. Abscesses are to be opened, mopped with pure carbolic acid, and dressed antiseptically. Stimulants and nourishing diet are imperatively demanded. Morphin is necessary for the muscular pain, restlesshts, and insomnia. Digitalis is given to stimulate the circulation and kidby secretion. Sulphur iodid and arsenite of strychnin have been used. Diseased horses ought at once to be killed and their stalls should be torn to purified, and entirely rebuilt. A man with chronic glanders should removed to the seaside. The nasal passages must be kept clean and the ulers must be cauterized and dressed with iodoform gauze. Nutritious foods, linics, and stimulants are necessary.

Treatment by frequent small doses of mallein finds advocates. It has been suggested that injection of the serum of the blood of an immune animal (the ox, for instance) might be serviceable.

Actinomycosis is a specific infectious disorder characterized by chronic inflammation, and is due to the presence in the tissues of the actinomyces or

ray-fungi. As stated on page 18 the ray-fungus occupies a position between bacteria and moulds and more than one variety of the fungus exists. Some of the varieties are pathogenic, others do not seem to be. It is an aërobic but when dried is not at once killed, but months after may develop if placed under favorable conditions. When growing in the tissues it usually forms numerous distinct aggregations, each about the size of a sand grain, and called from their color sulphur grains. Usually the growths lie in purulent matter If purulent matter containing growths is rubbed between the fingers it wil give a gritty sensation like sand if the growth is not very recent. of the fungi causes the formation of an infective granuloma and great masses of granulation tissue may form with collections of necrotic or purulent matter here and there, and zones of fibrous tissue. The fungi are easily discovered in the sulphur grains with the microscope, but if the fungi are mycelial and are scattered instead of being gathered into granules it is difficult to discover them. This disease occurs in cattle (lumpy jaw) and in pigs, and can be transmitted to man, usually by the food. At the point of inoculation (which is generally about the mouth) arises an infective granuloma, around which inflammation of connective tissue occurs, suppuration eventually taking place. Inoculation in the mouth is by way of an abrasion of mucous membrane or through a carious tooth. Chewing straw which contains the fungi is the most common method of infection. The ray-fungi may pass into the lungs, causing pulmonary actinomycosis; into the intestines, causing intestinal actinomycosis; into the skin, the bones, the subcutaneous tissues, the heart, the brain, the liver, the urinary organs, etc. Abdominal anthrax is the commonest form and comprises nearly 50 per cent, of cases. Cases of human actinomycosis until very recently were looked upon as sarcomata. Many sinuses form, ulcers develop, but large abscesses do not arise.

The pus of actinomycosis contains many sulphur-yellow bodies visible to the naked eye and composed of fungi. These bodies usually feel gritty when rubbed between the fingers because of the presence of lime salts.

In actinomycosis the adjacent lymph-glands are very seldom involved unless there is secondary pyogenic infection, and if metastasis occurs it takes place by the veins. The condition causes but slight pain. A diagnosis must be made from syphilis, sarcoma, carcinoma, and tuberculosis. The formation of a tumor, followed by sinuses and ulceration, the ulcer having thin, non-indurated, undermined edges and edematous granulation, and adjacent pus cavities joining by sinuses, the appearance of the pus and the microscopic study of the discharge are significant. An actinomycotic ulcer may partially heal here and there. It is well to remember that an individual with actinomycosis may react to tuberculin like a person with tuberculosis. The muscular and connective tissues become infiltrated and hard, as though a coagulating material had been injected into them (Poncet and Bérard, in "Lyon Médicale," March 27, 1904). Edema and induration extend wide of the active focus of disease. Actinomycosis may last for years or it may prove fatal.

Cutaneous actinomycosis may be secondary to visceral infection with the disease, may be a purely local condition, or may be associated with some adjacent area of bone infection. The gummatous form of actinomycosis resembles a gummatous syphilitic area, and in it many small purulent pockets open by fistulæ (Monestié).

In the anthracoid form there are no distinct purulent collections, but many fistulæ discharge pus at various points (Monestié).

An area of cutaneous actinomycosis' is characterized by the existence of violet, blue, gray, or black maculæ, varying in size from that of a pin's head to that of a bean, the center of each macule being white and containing a minute quantity of pus (Derville).

In actinomycosis of bone the bone enlarges and becomes painful, the parts adjacent swell from infiltration and soften, pus forms and reaches the surface through fistulæ, and the skin becomes involved secondarily.

Abdominal actinomycosis takes origin from the gastro-intestinal tract, an actinomycotic nodule of the intestine having ulcerated, adhesions having formed, and an actinomycotic abscess having arisen, or actinomycotic disease of the intestine having spread. In over 50 per cent. of cases of abdominal actinomycosis the cecum is the part attacked. A fecal fistula may form and the liver may be involved. At leat 150 cases of actinomycosis of the appendix have been reported. A mass containing putrid pus develops. If not evacuated, fistulæ form. It is a very chronic condition and although fistulæ may heal, they break open again and again (Short, in "Lancet," Sept. 14, 1907). The fungi may be found in the stools.

The mortality of actinomycosis depends upon the site of infection, the question of secondary infection, and the plan of treatment. If pyogenic infection occurs, fatal pyemia may arise. The prognosis is reasonably good in many cases. The majority of cutaneous cases (nearly 90 per cent.) and many oseous cases can be cured. The mortality in the abdominal cases is large. Grill says that of 77 abdominal cases treated surgically 45 died, 22 recovered, and 10 were improved. Frazier ("Keen's System of Surgery") tells us that the mortality of the reported cases of actinomycosis in the United States was 47 per cent., and quotes Jiron as follows regarding the mortality of the various forms: Face and neck, 11 per cent.; thorax, 83 per cent.; abdomen, 71 per cent.; brain, 100 per cent. Actinomycosis has a strong tendency to redevelop even after apparently thorough excision. A case of cutaneous actinomycosis of the arm, seen by the author, was operated on twenty times. Ulceration took place into the axillary artery and death was narrowly averted. Recovery finally ensued. I have seen three cases of human actinomycosis: one was the patient just referred to; another was a mattress stuffer (straw being used), his lesions were on the chest and jaw and recovery followed operation; the third was a stable hand, who died from lesions of the face, jaw, and

Treatment.—Free excision if possible; otherwise incision, scraping, cauterization with pure carbolic acid or silver nitrate, and packing with iodoform gauze. If possible, remove the entire area; if not possible, remove all we can. Sinuses must be widely opened, each collection of pus must be drained, and granulation tissue if not extirpated must be scraped away with a sharp spoon. Give internally large doses of iodid of potassium. This drug alone has cured many cases. It is given for a week or two and is then discontinued for one week. Von Eiselsberg advocates the use of tuberculin injections. In a fistula from intestinal or appendical actinomycosis give potassium iodid and sulphate of copper (Bevan) and irrigate the sinuses with diluted tincture of iodin. Cases of actinomycosis should be placed under the best hygienic con-

ditions, should live, as far as possible, in the sunlight and open air, and should

be given nutritious diets, tonics, and often stimulants.

Blastomycosis.—The very existence of this disease has been denied, but numerous cases have been reported and most observers regard it as an entity. It may be a local infection (cutaneous blastomycosis), but in some cases the disease is generalized (systematic blastomycosis). The disease was first described by Gilchrist in 1894. It is found in North America, South America, Europe, and the East.

It is due to infection with a variety of yeast fungus. In the skin it begins as a papule or an indurated pustule, which becomes crusted and finally warty, enlarges at the periphery, and becomes surrounded by more recently developed lesions. The area becomes studded with minute abscesses, crusted foci, and

areas of bleeding granulations. Here and there healing may occur.

The disease may arise on any portion of the body, but the hands and face are most liable to it. The disease is slow in progress and lasts for many months. If it progresses, it will finally produce systemic blastomycosis or secondary infection will produce fatal septicemia.

Treatment.—In some cases excision, in others the x-rays. Potassium

iodid is useful.

## XVI. SYPHILIS OR POX.

Definition.—Syphilis is a chronic contagious, and sometimes hereditary, constitutional disease. It is one of the most common of diseases and comes next to tuberculosis as a cause of death. Lesser states that in Berlin, of men over twenty-five years of age who come to autopsy, 9 per cent. are syphilitic. In the United States it is twice as frequent among negroes as compared with whites, although in them the disease is apt to be more curable and less disastrous. It was long believed that only members of the human family could take syphilis, but Metschnikoff and Roux have succeeded in inoculating chimpanzees ("Annals of Pasteur Institute," Dec., 1903). These two observers have inoculated many animals and have shown that the nearer the animal is to man, the more nearly the disease resembles human syphilis. Anthropoid apes can be successfully inoculated, but only in the chimpanzee are human symptoms accurately produced. Its first lesion is an infecting area or chancre, which is followed by lymphatic enlargements, eruptions upon the skin and mucous membranes, affections of the appendages of the skin (hair and nails), "chronic inflammation and infiltration of the cellulovascular tissue, bones, and periosteum" (White), and, later, often by gummata. This disease is probably due to a microbe, but Lustgarten's bacillus has not been proved to be the cause. One fact against it being the cause is its presence in the non-contagious late gummata. The spirochæta pallida occurs in the contagious lesions and there seems little doubt that it is the cause. It is demonstrated in recent scrapings from specific lesions. The more contagious the lesion, the more of the organisms are found. The later the lesion, the fewer the organisms found. The presence of a great number means a malignant case. They tend to disappear under mercurial treatment (see pp. 331 and 336). Fenger maintains that syphilitic fever is due to absorption of toxins; that the eruptions of skin

and mucous membranes in the secondary stage arise from local deposit and multiplication of the virus; that many secondary symptoms result from nutritive derangement caused by tissue-products passing into the circulation, that the virus exists in the body after the cessation of secondary symptoms, and that it may die out or may awaken into activity, producing "reminders."

During the primary and secondary stages fresh poison cannot infect, and this is true for a long time after the disappearance of secondary symptoms. As a matter of fact, the immunity generally lasts for life and reinfection is one of the rarest of occurrences. Most supposed cases of reinfection were really instances of a fresh outbreak of an old disease. Some undoubted cases of reinfection have been reported. Immunity in the primary stage is due to products absorbed from the infected area. Colle's immunity is that acquired by mothers who have borne syphilitic children, but who themselves show no sign of the disease. Profeta's immunity is the immunity against infection possessed by children born of syphilitic parents. Some of these children have never shown signs of disease, but nevertheless they are immune. It is claimed that a person long free from active syphilis, but still immune, can transmit an immunity to his children. Tertiary syphilitic lesions are not due to the poison of syphilis, but to tissue-products resulting from the action of that poison, or to nutritive failure as a consequence of the disease. Tertiary syphilis is

not transmissible, but it secures immunity.

Transmission of Syphilis.—This disease can be transmitted—(1) by contact with the tissue-elements or virus-acquired syphilis; and (2) by hereditary transmission-hereditary syphilis. The poison cannot enter through an intact epidermis or epithelial layer, and abrasion or solution of continuity is requisite for infection. Syphilis is usually, but not always, a tenereal disease. It may be caught by infection of the genitals during coition, by infection of the tongue or lips in kissing, by smoking poisoned pipes, by trinking out of infected vessels, or by beastly practices. Syphilis not due to sexual relations is called syphilis of the innocent. The barber is a danger, and cases are reported as following razor cuts and particularly the applicafion of the alum stick to arrest bleeding. This stick is used over and over again and dried blood is often to be found upon it. I was consulted by a man who had been thus infected. I have treated two young girls infected by dentist's instruments, a policeman infected by a pipe, a glassblower infected from the blowpipe, a street car driver who got the disease from a borrowed whistle, a police officer who got it striking a prisoner on the mouth and cutting his own knuckle on the teeth, a hospital orderly who infected his nose by picking it with a contaminated finger, and a physician who caught it from a patient. Bulkley ("Jour. Am. Med. Assoc.," March 4, 1905) collected 1863 ass following vaccination; 170 following circumcision; 82 following tattoomg and 745 following cupping or venesection. The initial lesion of syphin may be found on the finger, penis, eyelid, lip, tongue, cheek, palate, abium, vagina, anus, nipple, etc. Bulkley found that in 1810 non-genital cases the chancre was on the lip, in 1148 on the breast, in 734 in the mouth, in 432 on the hand or one of the fingers, in 372 about the region of the eye, and in 307 on the tonsil. A person may be a host for syphilis, carry it, give It to another, and yet escape it himself (a surgeon may carry it under his hails and a woman may have it lodged in her vagina). Syphilis can be

transmitted by vaccination with human lymph which contains the pus of a syphilitic eruption or the blood of a syphilitic person. Vaccine lymph, even after passage through a person with pox, will not convey syphilis if it is free from blood and the pus of specific lesions; it is not the lymph that poisons, but some other substance which the lymph may carry. When syphilis is caught from one of a different race the disease is apt to run a peculiarly severe course. The apprehensions of the sailor regarding "Chinese pox" are probably well founded.

Effect of Syphilis upon Longevity.—This is a difficult matter to determine. Many deaths result from diseases caused by syphilis and yet they are not certified as due to syphilis. My own belief is that the mortality directly due to syphilis is very small indeed (except in cases of congenital syphilis), but that the mortality indirectly due to it is very large. I think that the life insurance companies are justified in requiring those who have had syphilis to

pay higher premiums than those who have never had the disease.

Syphilis and Tuberculosis.—Syphilis and tuberculosis may exist. The syphilis may be severe and the tuberculosis mild or vice versā. In some cases neither is severe and in some cases both are. As a rule, they have an unfavorable influence on each other. Tuberculosis is not very unusual in the course of secondary syphilis. It is apt to run a rapid course because of the patient's debility and worry and because of the treatment employed for the syphilis. Old syphilitics may develop tuberculosis, but do not seem particularly prone to do so. A child born syphilitic is very apt to become tuberculous, more apt even than is a child born of tuberculous parents. If a patient who is thought to be well of syphilis becomes tuberculous the syphilis may crop out again. If a tuberculous patient becomes syphilitic the tuberculosis gets worse. It is well known that syphilitic ulcers may become tuberculous. This sometimes occurs in the larynx. (See chapter on Syphilis in Bonney's treatise on "Pulmonary Tuberculosis.")

Syphilitic Stages.—Syphilis was divided by Ricord into three stages:

(1) the primary stage—chancre and indolent bubo; (2) the secondary stage—disease of the upper layer of the skin and mucous membranes; and (3) the tertiary stage—affections of connective tissues, bones, fibrous and serous membranes, and parenchymatous organs. This division, which is useful clinically, is still largely employed, but it is not so sharp and distinct as was believed by Ricord; it is only artificial. For instance, ozena may develop during a secondary eruption, and bone disease may appear early in the case.

Syphilitic Periods.—White divides the pox into the following periods:

(1) period of primary incubation—the time between exposure and the appearance of the chancre; from ten to ninety days, the average being twenty-five days;

(2) period of primary symptoms—chancre and bubo of adjacent lymph-glands;

(3) period of secondary incubation—the time between the appearance of the chancre and the advent of secondary symptoms: about six weeks as a rule;

(4) period of secondary symptoms—lasting from one to three years;

(5) intermediate period—there may be no symptoms or there may be light symptoms which are less symmetrical and more general than those of the secondary period: it lasts from two to four years, and ends in recovery or tertiary syphilis;

(6) period of tertiary symptoms—indefinite in duration. The fifth and sixth periods may never occur, the disease having been cured.

Primary Syphilis.—The primary stage comprises the chancre or infecting sore and bubo. A chancre or initial lesion is an infective granuloma resulting from the poison of syphilis and is most usually met with upon the genital organs. A chancre may be derived from the discharges of another chancre, from the secretion of mucous patches and moist papules, from syphilitic blood, or from the pus or secretion of any secondary lesion. Tertiary lesions cannot cause chancre. It appears at the point of inoculation (page 313), and is the first lesion of the disease. During the three weeks or more requisite to develop a chancre the poison is continuously entering the system, and when the chancre develops the system already contains a large amount of poison. A chancre is not a local lesion from which syphilis springs, but is a local manifestation of an existing constitutional disease, hence excision is entirely useless. If we take the discharge of a chancre and insert it at some indifferent point, into the person from whom we took it, a new indurated chancre will not be formed, because the individual already has syphilis, but auto-inoculation with the discharge of an irritated chancre can cause a non-indurated sore. If we take the discharge of a chancre and insert it into a healthy person, an indurated chancre follows. Hence we say that primary syphilis is not auto-inoculable, but is hetero-inoculable. A soft sore can be produced in the lower animals by inoculation with the virus of a chancre, but a hard sore cannot except in chimpanzees. Some observers, notably Kaposi, of Vienna, advocate the unity theory. This theory maintains that both hard and soft sores are due to the same virus, the infective power of the soft chancre simply being less than that of the hard sore, the possibility of constitutional infection depending, not upon differences in the poison, but rather upon differences in the soil and in the local processes. The unicists advocate excision of chancres, soft or hard, to prevent, if possible, constitutional involvement. Most syphilographers believe in the duality theory, which we have previously set forth. This theory took origin from the classical investigations of Bassereau and Rollet. The duality theory maintains that the soft sore is caused by a poison different from that which originates the hard sore, and that a true soft sore never infects the system.\*

Initial Lesions.—An initial lesion, hard chancre, or infecting sore never appears until at least ten days after exposure; it may not appear for many weeks, but it usually arises in about twenty-five days. There are three duel forms of initial lesion: (1) a purple patch exposed by peeling epidermis, without induration and ulceration—a rare form; (2) an indurated area under the epidermis, without ulceration—a very common form; and (3) a round, indurated, cartilaginous area with an elevated edge, which ulcerates, exposing a velvety surface looking like raw ham; it bleeds easily, rarely suppurates, does not spread, and the discharge is thin and watery. This is the "Hunterian chancre," which is rarer than the second variety, but commoner than the first, and which ulcerates because of dirt, caustic applications, or friction.

A chancre is rarely multiple; but if it is so, all the sores appear together as a result of the primary inoculation; they do not follow one another because of auto-infection. A hard sore does not suppurate unless irritated by caustics, friction, or dirt, or unless there be mixed infection with chancroid; its nature

<sup>\*</sup>For a full discussion of these points see the writings of Fournier, Alfred Cooper, and won Zeissl, and especially the great work of Taylor.

is not to suppurate. The hardness may affect only the base and margins of an ulcer or it may affect considerable areas, but it has well-defined margins and feels like cartilage encapsuled, so that it can be picked up between the fingers. This hardness or sclerosis is due to gradual inflammatory exudation into "the tissue at the base of the ulcer and to growth of the nodule" (von Zeissl). It feels distinct from the surrounding tissues, like a foreign body lying in the part. A chancre untreated may last many months. The induration usually disappears soon after the appearance of secondary symptoms. A copper-colored spot remains, and does not disappear until the disease is cured. Induration may again appear before the outbreak of some distant lesion.

Mixed Infection of Chancre and Chancroid.—Von Zeissl says: "If syphilitic contagion is mixed with pus, a chancre begins as a circumscribed area of hyperemia and swelling, which undergoes ulceration, and does not develop hardness for a period of from ten days to several weeks, and may develop a nodule after the first ulcer has entirely healed." This condition is seen when mixed infection occurs, the chancroid poison being quick, and the syphilitic poison being slow, to act. If chancroid poison is deposited some time after the syphilitic poison has been absorbed, the induration may appear in a few days after the chancroid begins. A soft chancre may appear upon an

existing syphilitic nodule and may eat out the induration.

Diagnosis of Chancre.—It is necessary to distinguish a chancre from a chancroid and from ulcerated herpes. A chancroid appears in from two to five days after contagion (always less than ten days); it may be multiple from the start, but, even if beginning as one sore, other sores appear by auto-inoculation; it begins as a pustule, which bursts and exposes an ulcer; the ulcer is circular, has thin, sharp-cut, or undermined edges, a sloughy, non-granulating base, and gives origin to a thin, purulent, offensive discharge which is both auto- and hetero-inoculable. These soft sores have no true sclerotic area, do not bleed, produce no constitutional symptoms, and are apt to be followed by acute inflammatory buboes which tend to suppurate. A chancroid causes pain, and the original ulcer enlarges greatly. A chancre appears in about twenty-five days after inoculation (never before ten days); it is generally single, but if multiple sores exist, they all appear together, for their discharge is not auto-inoculable if the sore is not irritated; an auto-inoculation of the products of an irritated chancre can at most produce only a soft purulent ulcer. A chancre begins as an excoriation or as a nodule; if an ulcer forms, its floor is covered with granulations and it is red and smooth; the discharge is thin and scanty and not offensive; the edges are thick and sloping; it is surrounded by an area of induration, and bleeds when touched, there appear about the same time with it indolent multiple enlargements of the adjacent glands, which rarely suppurate, and it is followed by secondary symptoms. A chancre causes little pain, and after it has existed for a few days rarely shows any tendency to spread. A urethral chancre appears after the usual period of incubation; it is situated near the meatus, one lip of which is usually indurated; the discharge is slight, often bloody, never purulent; indurated multiple buboes arise; the sore can be seen, and constitutional symptoms follow.

Herpetic ulceration has no period of incubation; it may follow fever, but usually arises from friction or irritation due to dirt or acrid discharges. It appears as a group of vesicles, all of which may dry up, or some may dry up and others ulcerate, or they may run together and ulcerate. The edges of an herpetic ulcer are in "segments of small circles" (White); the ulcer is superficial, has but little discharge, and does not have much tendency to spread; it has no induration; it is painful; it is not accompanied by bubo unless suppuration is extensive. Herpes is not followed by constitutional involvement.

A chancre may be mistaken for cancer of the tongue. "A chancre of this region is brownish-red, a cancer being bright red. A chancre is soft in the center; a cancer presents uniformity of induration. A chancre gives origin to a thin, purulent discharge, free from blood; a cancer furnishes a non-purulent, bloody discharge. A chancre is soon followed by indolent lymphatic enlargements under the jaw; a cancer is followed by painful enlargements." A cancer is slower in evolution, is not followed by constitutional symptoms, and the lymphatic enlargements are much later in appearing than in chancre.

Phagedena.—A chancre or a chancroid may be attacked by phagedena, a destructive form of ulceration which was once common, but at present is rare. The ulceration often spreads on all sides and also deeply into the tissues. In some cases it spreads at the edge in one direction (serpiginous ulceration), in some cases sloughing occurs. Phagedena occurs only in the debilitated (anemic, drunkards, strumous subjects, sufferers from diabetes, Bright's disease, etc.; salivation can cause it). The phagedenic ulcer is irregular, with congested and edematous edges, and a foul, sloughy floor.

Chancre Redux.—Some observers believe that reinfection with syphilis is not very unusual. Most authorities maintain that it is very rare. The latter school maintains that the region once occupied by a chancre may, after many years, become indurated anew. Fournier pointed out this fact thirty years ago. Such a reinduration is called *chancre redux*, or relapsing chancre.

If syphilitic manifestations follow such an induration, we must conclude that reinfection has truly occurred. If they do not follow, and this is the rule, the lesion is not really a chancre, but is probably a gumma in an early stage of

development. Mauriac pointed out this last fact.\*

Syphilitic Bubo.—In syphilitic bubo anatomically related lymphatic glands enlarge about the same time as induration of the initial lesion begins. In the very beginning these glands may be a little painful, but the pain is slight and of temporary duration. These enlargements are called "indolent luboes"; they may be as small as peas or as large as walnuts, are freely movable, and very rarely suppurate. The lesion of the glands is hyperplasia of all the gland-elements and of their capsules, due to absorption of the virus. If the patient is tuberculous, the bubo is apt to become enormous, lobulated, and persistent. If the chancre appears on the penis, the superficial inguinal and femoral glands enlarge, usually on the same side of the body as the sore. If the sore is on the frenum, both groins are involved. If a chancre appears on the lip or tongue, the bubo is beneath the jaw. These buboes may remain for many months; they do not suppurate unless the sore suppurates or unless the patient is of the tuberculous type; and they finally disappear by absorption or fatty degeneration. About six weeks after buboes have formed in the

Mraček, in Wien. klin. Rundschau, 1896. H. G. Antony, in Chicago Medical Retorder, April, 1899.

glands related to the lesion all the lymphatics of the body enlarge. General lymphatic involvement arises about the same time as the secondary eruption. The enlargement of the post-cervical and epitrochlear glands is diagnostically important. Glandular enlargements persist until after the eruptions have

disappeared.

Glandular enlargement always occurs in syphilis, but the bubo exists in only one-third of the chancroid cases. The bubo of syphilis is multiple, consisting of a chain of movable glands (the glandulæ Pleiades of Ricord); the bubo of chancroid is one inflamed and immovable mass. The bubo of syphilis is indurated, painless, small, and slow in growth; the bubo of chancroid shows inflammatory hardness, is painful, large, and rapid in growth; the first rarely suppurates, the second often does. The skin over a syphilitic bubo is normal; that over a chancroidal bubo may become red and adherent. A syphilitic bubo is not cured by local treatment, but is cured by the internal use of mercury and is followed by secondary symptoms. A chancroidal bubo requires local treatment, is not cured by mercury, and is not followed by secondaries. Herpes, balanitis, and gonorrhea rarely cause bubo, but when they do the bubo in each case is similar to that caused by chancroid. A positive diagnosis of syphilis can be made when an indurated sore on the penis is followed by multiple indolent buboes in the groin and by enlargement of distant glands.

General Syphilis.—As the general lymphatic enlargement becomes manifest a group of symptoms known as "syphilitic fever" may appear. In many mild cases, however, fever is absent and the eruption is the first sign of constitutional involvement. The patient usually thinks he has a severe cold, is feverish and restless; complains of headache, lassitude, sleeplessness, and anorexia; his face is pale; he has intermitting rheumatoid pains in the joints and muscles, especially of the shoulders, arms, chest, and back, which pains change their location constantly and prevent sleep; night-sweats occur, and the pulse is quite frequent. The fever usually reaches its height in fortyeight hours, and falls as the eruption develops. The eruption develops usually in from forty-eight to seventy-two hours after the onset of the fever, but may not do so for one week or even more. The fever and the discomfort are worse at night. In type the fever may be intermittent, remittent, or continued. Prolonged syphilitic fever with delay in the appearance of the eruption gives rise sometimes to great errors in diagnosis. In syphilitic fever there are anemia, trivial leukocytosis, and a marked fall in hemoglobin. Syphilitic fever may reappear during the progress of the disease.

Secondary Syphilis.—The phenomena of secondary syphilis are due to poisoned blood. Fenger states that the poison is present in the blood during outbreaks, but not during the quiescent periods between outbreaks. Secondary syphilis is characterized by plastic inflammation, by the formation of fibrous tissue, and by thickening of tissue. Superficial ulcerations

may occur. Structural overgrowths appear (for instance, warts).

Syphilitic Skin Diseases.— Syphilodermata (syphilides) are due to circumscribed inflammation, and may be dry or purulent. There is no one eruption characteristic of syphilis. This disease may counterfeit any skin disease, but it is an imitation which is not perfect and is never a counterpart. Syphilitic eruptions are often circumscribed; they terminate suddenly at their edges, and do not gradually shade into the sound skin. In color they are apt

to be brownish-red, like tarnished copper; especially is this the case in late syphilides. Hutchinson cautions us to remember that an ordinary non-specific eruption may be copper-colored, especially in people with dark complexions and when it occurs on the legs. Eruptions are apt to leave a brownish stain. Early syphilitic eruptions are symmetrical. Syphilitic eruptions have an affection for particular regions, such as the forehead, the abdomen and chest, the neck and scalp, about the lips and the alæ of the nose, the navel, anus, groins, between the toes, and upon the palms and soles. Early secondary eruptions rarely appear on the face or hands. Specific eruptions are polymorphous, various forms of eruption being often present at the same time, so that roseola is seen here, papules there, etc. These syphilides do not cause as much itching as do non-specific eruptions, except when they occur upon the scalp, about the anus, or between the toes. The late secondary eruptions tend to an arrangement in curved lines.

Forms of Eruption.—The chief forms of eruption are: (1) erythema, (2) papular syphilides, (3) pustular syphilides, and (4) tubercular syphilides. Besides these eruptions pigmentation may occur (pigmentary syphilide),

and blood may extravasate (purpuric syphilide).

Prince A. Morrow does not believe in erecting the vesicular syphilides into a special group. He tells us that vesicles sometimes form on erythemato-papular lesions, but their presence is an accident and not a regular phenomenon. So, too, the bullous syphilide is a rare accident in a case, and even when it occurs soon becomes pustular. The pemphigoid syphilide is found almost exclusively in hereditary disease.\*

L. Erythema (maculæ, roseola, or spots). This eruption usually comes on gradually, crop after crop of spots appearing, and many days passing before an extensive area is covered. Occasionally, however, it arises suddenly (after a hot bath, after taking violent exercise, or after eating an indigestible meal). This eruption consists of circumscribed, irregularly round, hyperemic spots, about one-eighth of an inch in diameter, whose color does not entirely disappear on pressure in an old eruption but does in a recent one. The color sat first light pink, but it becomes red, purple, or even brown. In the papular form of erythema the spots are slightly elevated. Erythema is rare upon the face and the dorsum of the hands and feet. It attacks especially the chest and belly, but appears often on the forehead, the bend of the elbow, and the inner portion of the thigh, the neck, and the flexor surface of the forearms and arms. It appears first on the abdomen and last on the legs. Usually crythema follows syphilitic fever, about six weeks after the chancre appears, and the number and distinctness of the spots are in proportion to the violence of the fever. No fever or slight fever means there will be but few spots and they will soon disappear. In rare cases the eruption is very transitory, lasting but a few hours, but it usually continues for several weeks if untreated. It may pass away or may be converted into a papular eruption. Mercury will cause it to disappear in a couple of weeks. In examining for this form of eruption in a doubtful case, let cold air blow upon the chest and belly (Hearn); this blanches the sound skin and makes clear any discoloration. No desquamation attends the macular eruption, but a brownish stain remains for a variable time after the eruption fades. Erythema means, as a rule, a mild and

<sup>\*</sup>Motrow's "System of Genito-urinary Diseases, Syphilology, and Dermatology."

curable attack. Maculæ may be combined with the next form, constitute a maculopapular eruption.

The maculopapular syphilides are evolved from the macular syphilides. They are slightly elevated, are situated upon hyperemic bases, and the sumits of some of them may undergo slight desquamation. A roseolar armay show one or several of these macular papules. They are apt to arrange themselves in segments of a circle, and are symmetrically distributed. The eruption usually appears early, but may appear late. It may fade and reapear several times in the same patient. The eruption lasts a few weeks.



Fig. 124.—Condylomata (Horwitz).

2. Papular syphilides, which are papules or elevations covere with dry skin, may or may not des quamate. If they do desqua mate, the process begins over th center. They usually appea from the third to the sixth mont of the disease. They may be pre ceded by fever, and often reap pear again and again. They ar at first small and red, but becom larger and brownish. They ar firm in feel and vary in size from the head of a pin to a five-cen piece or larger. Very large papule constitute nummular syphilides They all tend to scale. The ep derm becomes thin, red, and glis tening, splits in the center and des quamates, and a fringe of epidermi surrounds the desquamated are This process may be repeated one or oftener. When lenticular par ules recur in the late secondar stage they are apt to group them selves in circles limited to particu lar regions (annular or circinat

syphiloderm). They may be present as miliary papules, lenticular papules moist papules, and papules with marked epidermic proliferation resemblin psoriasis (papulo-squamous eruption). Papules on fading leave very persist ent coppery-looking stains. Papules upon the palms and soles constitute the so-called "palmar and plantar psoriasis," which appears from three months to one year after the appearance of the chancre. Papules just below the line of the hair on the forehead constitute the corona veneris. Papular syphilide appear especially upon the forehead, the neck, the abdomen, and the extremities. The papular or squamous syphilide of the palms and soles begins as red spot which becomes elevated and brownish; the epidermis thickens and it cast off, and there then remains a central red spot surrounded by undermine skin. If papules are in regions where they are kept moist (as about the anus they become covered with a sodden gray film which after a time is cast off an

leaves the papule without epidermis. The sodden papules are called flat condylomata, moist or humid papules or plates (Fig. 124). Papules which are at first small may become large. The small or miliary papules constitute syphilitic lichen. The lenticular papules are most common, and strongly tend to scale off. The papular syphilides give a worse prognosis for the constitutional disease than do spots. The syphilitic negro is particularly apt to develop the annular syphiloderm.

3. Pustular syphilides arise from papules. The condition is known as acne when the apex of the papule softens, impetigo when the whole papule suppurates, and ecthyma or rupia when the corium is also deeply involved. Vesicles occasionally precede pustules. The pustular eruption appears a number of months after infection and later than the papular. The pustular eruption gives a very bad prognosis for the constitutional disease. Rupia is formed by a pustule rupturing or a papule ulcerating, the secretion drying and forming a conical crust which continually increases in height and diameter, while the ulceration extends at the edges. When the crust is pulled off there is seen a foul ulcer with congested, jagged, and undermined edges. Rupia may be secondary or tertiary, and it invariably leaves scars. It appears only after at least six months have passed since the chancre began. Secondary rupia is symmetrical.

4 Tubercular syphilides are greatly enlarged papules intermediate

between ordinary papules and gummata.

Diagnosis between Secondary and Tertiary Syphilides.—A secondary eruption is distinguished from a tertiary eruption by the following: the first tends to disappear, the second tends to persist and to spread; the first is general and symmetrical, the second is local and asymmetrical; the first does not spread at its edge, the second tends to spread at its edge, and this tendency, which is designated "serpiginous," produces an ulcer shaped like a horseshoe [Jonathan Hutchinson]. Secondary lesions appear within certain limits of time, develop regularly, and are dispersed by mercurial treatment. Tertiary lesions appear at no fixed time, develop irregularly, and are not cleared up by mercury.

Affections of the Mucous Membranes.—The chief lesions in syphinic affections of the mucous membranes are mucous patches, warts, and undylomata. The first phenomena of secondary syphilis are, as a rule, symmetrical ulcers of the tonsils, painless, of temporary duration, and superbial (Hutchinson). The borders of the ulcers are gray, and the areas are remiform in shape. Catarrhal inflammations often occur. Eruptions appear on the mucous membranes as upon the skin. Mucous patches are papules deprived of epithelium; they are gray in color, are moist, and give off an offensiveand virulent discharge. They usually appear as areas of congestion, swelling, and abrasion of the epidermis upon the lips, palate, gums, tongue, cheeks, vagina, labia, vulva, scrotum, anus, and under the prepuce. A moist papule of the skin is really a mucous patch. These patches, which are always circular or oval, are among the most constant lesions of the secondary stage, appearing from time to time during many months. If a patch has the papillæ destroyed, is called a "bald patch." If the papules present hypertrophied papillae fued together, there appear enlargements with flat tops, termed condylomata; if the papillæ of the papules hypertrophy and do not fuse, the growths are

Alle tong of the Lat. There are incarment of hearing in one or of the ear. Rarely, per the control of the ear. Rarely, per the control of the ear of the ear of the ear.

After terms of the Bones and Joints.—It synhilis there may be slight to the secondary of the transple point. Observer established usually arises to the form of the transple point. Observer established usually arises to the form of the transple point, but in rare instances present the transple of the transple to the library end to the transple of the transple of a condition of the arrangement may be to perfect the may form a soft node which by the transple come a hard node. Pala like that of rheumatism may affect the good. The not mercal of by motion and is worse at night. Such pains to be not mean annountment and in one cases are very severe. The joints of not of the coupt perhaps on rising. Paton reminds us that such arthralgis of the other motion and may actually antedate the secondary eruption ("Brit

Med. Jour.," Nov. 28, 1903). More common than the above condition is synovitis, acute or chronic. It often comes on rapidly without other symptoms and is announced by swelling, tenderness, and pain. In some cases the pain is severe, and the patient is feverish or actually ill. Such cases constitute what is called syphilitic rheumatism, but the profuse sweats of acute rheumatism are absent, the heart is never attacked, the skin is not red, the fever is not high, and the condition is not migrating (Paton, in "Brit. Med. Jour.," Nov. 28, 1903). Hydrarthrosis may arise in the knee as a sequence of either of the above conditions, or, late in the secondary stage, it may arise without such an antecedent trouble (Paton). Symmetrical synovitis has been noted. Secondary syphilitic disease of bone, periosteum, and joints lasts only a short time and is never destructive.

Affections of the Eye.—Iritis is the commonest eye trouble which may arise during secondary syphilis. It appears from three to six months after the chance, and begins in one eye, the other eye soon becoming affected. The symptoms are a pink zone in the sclerotic, a congested, red or muddy iris, irregularity of the pupil accentuated by atropin, the existence of pain and photophobia, and sometimes hazy or even clouded pupil. Rheumatic iritis causes much pain and photophobia, syphilitic iritis comparatively little; there is less swelling in the first than in the second; the former tends to recur, the latter does not. Iritis is usually recovered from, good vision being retained. Diffuse retinitis and disseminated choroiditis never occur until a number of months have passed since the infection. The symptoms are failure of sight, muscæ volitantes, and very little photophobia. The diagnosis of retinitis and choroiditis is made by the ophthalmoscope.

Affections of the Testes.—Syphilitic Sarcocele.—The testicle enlarges because of plastic inflammation. Both glands usually suffer, but not always. Fluid distends the tunica vaginalis. The epididymis escapes. The testicle is not the seat of pain, is troublesome because of its weight, and has very little of the proper sensation on squeezing. The plastic exudate is generally largely absorbed, but it may organize into fibrous tissue, the organ passing

into atrophic cirrhosis.

The Albuminuria of Secondary Syphilis.—It is not very unusual by nephritis with albuminuria to develop early in the secondary stage. There may be the ordinary symptoms of nephritis, but in many cases there is albuminuria and nothing more. Large amounts of albumin run away from the tidneys and the high percentage of albumin in the urine is a notable feature. Many of these cases recover completely, some become chronic, and in some death ocurs. It seems probable that mercurial treatment is, in part at least, responsible for some of these cases. The syphilitic poison causes the others. Those is which there is albuminuria and nothing more are due to syphilis rather than to mercury. Those in which there is dropsy are aggravated and perhaps caused by mercury (Fleissinger, in "Journal des Practicens," August 3, 1907).

Intermediate Period.—Secondary lesions cease to appear in from months to three years. In the intermediate period no symptoms and appear, but the disease is still for some time latent and is not cured. Symptoms may arise from time to time. These symptoms, which are called mainders," are not so severe as tertiary symptoms, are apt to be symmethal, and do not closely resemble secondary lesions. Among the reminders

we may name palmar psoriasis and sarcocele. Sarcocele in this stage is bilateral and rarely painful. Bilateral indolent epididymitis occasionally occurs. Sores on the tongue, a papular skin eruption, and choroiditis may arise. Gummata occasionally occur in this stage, but they are apt to be symmetrical and non-persistent (symmetrical superficial dactylitis). Arteriti may occur, beginning in the intima or adventitia, and causing, it may be, aneur ysm, thrombosis, or embolism. Obliterative endarteritis may cause gangrene Vascular changes are notably common in the vessels of the brain, and throm bosis may occur, in which case paralysis comes on gradually, preceded by numbness, although sudden paralysis may take place. These paralyses may



Fig. 125.—Syphilis of nose.

be limited, extensive, transitory or permanent. The nervous system often suffers in this stag (anesthetic areas and retinitis) The viscera are often congester and infiltrated (tonsils, liver spleen, kidneys, and lungs).

Tertiary Syphilis. — This stage is not often reached, the disease being cured before it has been attained. About 85 per cent of syphilitics escape it entirely. It is not so much a stage of syphilitian as a condition of impaired nutrition which results from the disease. This view finds confirmation in the fact that tertiary lesion

do not furnish the contagion. The primary stage disappears without treat ment, the secondary stage tends ultimately to spontaneous disappearance, bu tertiary lesions tend to persist and to recur. Tertiary lesions may be single or may be widely scattered; when multiple they are not symmetrical except by accident. These lesions may attack any tissue, even after many years of apparent cure; they all tend to spread locally, they all leave permanent atrophy or thickening, they all tend to relapse, and a local influence is often an exciting cause. Tertiary syphilis may cause marked anemia and it is sometimes the cause of pernicious anemia (Dumas and Pirrot, in "La Presse Médicale," xv. Nos, 39 and 40).

Tertiary skin-eruptions are liable to ulcerate. Various eruptions may occur: papular syphilides, pustular syphilides, gummatous syphilides, ser piginous syphilides, and pigmentary syphilides. The characteristic syphilide is rupia, which is formed by a pustule rupturing or a papule ulcerating. I brown or black crust forms because of the drying of the discharge, ulceration continues under the crust, new crusts form, and, as the ulcer is constantly increasing peripherally, the new crusts are larger in diameter than the old ones and the mass assumes the form of a cone. An ulcer which has destroyed the deeper layers of the skin is exposed by tearing off the crust. On healing a rupial ulcer always leaves a permanent scar.

Serpiginous ulcers are common in tertiary syphilis, and are especially common about the knees, nostrils, forehead, and lips. Serpiginous ulceration

is spoken of as *syphilitic lupus*. It is preceded by a widespread browncolored nodular cutaneous infiltration. The nodules suppurate, run together, crust, and produce an ulcer which spreads rapidly and assumes the shape of a horseshoe.

The Gumma.—The gumma is the typical tertiary lesion. In some cases there is a solitary gumma; in others, two or three or even many gummata. A gumma is a mass of granulation tissue, grayish-yellow in color, containing many cells and few fibers. Organization of the gumma fails to take place because of a want of sufficient blood-supply, the cellular mass is apt to undergo caseation, and when this occurs an ulcer forms. One portion of the mass may caseate, another portion may become fibrous. In some cases the entire gumma becomes fibrous. A gumma varies in diameter from one-eighth of an inch to two or three inches, presents a center of gummy degeneration, a surrounding area of immature fibrous tissue, and an outer zone of embryonic tissue and leukocytes. A gumma, when it is spontaneously evacuated, exhibits a small opening or many openings with very thin red and



Fig. 126.-Gumma of the clavicle.

undermined edges; the ulcer is slow to heal, and forms a thin scar, white in the center, but pigmented at the margins and usually depressed (Jonathan Hutchinson, Jr.). The gummatous ulcer is deep, circular in outline, with indermined edges and an uneven floor covered with a thick, white, adherent sough. Sometimes there is no slough, but an extensive area is infiltrated. A rummatous ulcer may coalesce with one or more adjacent ulcers. The dicharge is scanty and tenacious. These ulcers are often seen upon the and when once healed rarely recur. A gumma in the internal organs may become a fibrous mass. Gummata form in the skin, subcutaneous tissues, abmucous structures, muscles, tongue, joints, bursæ, testes, spinal cord, brain, and internal organs. In tertiary syphilis an inflammation may not form a cirunscribed gumma, but, instead, may produce a diffuse degenerating mass. This type of inflammation, which is seen in bones, is called "gummatous." In the nasal cavity a gumma is rapidly followed by an ulcer and there is a strong tendency to necrosis of the vomer and sometimes of the turbinated lines. This condition produces a foul discharge and is known as syphilitic Marag. Advanced necrosis of the nasal bones causes the nose to "fall in,"

which is a hideous deformity (Fig. 127). The commonest laryngeal lesion is multiple ulceration following minute gummata. A healing gumma in a mucous canal such as the rectum or larynx causes thickening and stricture. Tertiary syphilis is a common cause of amyloid degeneration and the most frequent cause of arterial and nervous sclerosis.

Various Lesions.—Hutchinson enumerates the lesions of tertiary syphilis as follows: Periostitis, forming nodes or causing sclerotic hypertrophy, or



Fig. 127.—Destruction of the nose in tertiary syphilis.

suppuration, or necrosis; gummata in various parts; disease of the skin of the type of rupia or lupus; gumma or inflammation of the tongue, causing sclerosis; structural changes in the nervous system, causing ataxia, ophthalmoplegia externa and interna, general paresis, optic atrophy, and paralyses of cerebral nerves; amyloid degenerations; and chronic inflammation of certain mucous membranes (of the mouth, pharynx, vagina, rectum, etc.), with thickening and ulceration. Gummatous infiltration of the evelid is sometimes observed. Gummatous osteoperiostitis of the vertebræ may arise, and this may be associated with disease of the membranes or cord. Syphilitic inflammation of vertebræ is called syphilitic spondylitis. Unilateral enlargement of the epididymis is sometimes noted, the mass feeling heavy, aching a little, but not being

very tender. Unilateral sarcocele may be met. Gumma may arise in the

iris, the larynx, the rectum, and the nose.

Tertiary Syphilis of Bones.—The bones particularly liable to disease are the skull, sternum, nasal septum, and tibia. The usual form is a gumma resulting in caries and necrosis. A superficial gumma causes syphilitic periostitis, a deep gumma, syphilitic osteomyelitis (McFarland's "Text-book of Pathology"). Periostitis affects particularly the superficial bones (tibia, clavicle, sternum, ulna, etc.). It begins in the deeper layer of the periosteum, swelling arises, gummy changes occur, and the bone beneath is more or less destroyed. In the skull the bone may be completely penetrated. Not unusually syphilitic periostitis arises at the seat of a trivial injury. Syphilitic osteomyelitis occurs particularly in the phalanges and skull. An area of syphilitic bone disease may undergo repair, osteosclerosis usually and osteoporosis sometimes resulting. Syphiliis of the bones of the nose is a necrosis resulting from gummatous ulceration.

Tertiary Dactylitis.—This condition is a gummatous formation in a finger or toe. There is a superficial form in which the deposit begins in the subcutaneous tissue and subsequently involves the joint ligaments. In a toe the entire digit is usually involved, in a finger the condition is usually limited to

the proximal phalanx. Superficial dactylitis is a very early tertiary phenomenon. A painless swelling gradually forms and it is most distinct on the dorsal surface. The swelling becomes purplish or reddish blue in color and the joint becomes preternaturally mobile. The swelling may ulcerate.

Deep dactylitis is a very late tertiary manifestation and is osteomyelitis and periositis of the fingers or perhaps of the toes. One or more proximal phalanges are apt to suffer. The skin seldom suffers. Caries and necrosis may occur and the joint may be destroyed, or the bone may be partially absorbed

and shortened from dry caries. Ulceration of the skin is rare.

Tertiary Syphilis of Joints.—(See the careful study of E. Percy Paton, in "Brit. Med. Jour.," Nov. 28, 1903). The knee-joint is most commonly affected. Chronic synovitis may arise with considerable or even great swelling (hydrarthrosis), trivial pain, slight functional impairment, some thickening of synovial membrane, and some harshness or grating on movement. Gummatous synovitis may arise, a condition which sometimes follows the ordinary synovitis, but more often exhibits very little swelling. The synovial membrane exhibits irregular areas of thickening and the symptoms resemble those of a tuberculous joint (Paton).

In some syphilitic joints the disease begins in the bone and cartilage. In such a condition there is rigidity, marked limitation of movement, pains not often severe, and some deformity (Paton). Again, as Paton points out, a joint may be involved by an adjacent syphilitic area, synovitis arising, or, if a gumma breaks into a joint, secondary pyogenic infection may follow. Anky-

losis may follow joint syphilis.

Visceral Syphilis.—Amyloid changes may occur in any of the viscera of an individual with tertiary syphilis, and such changes may be found in people in whom suppuration never occurred. The lungs may undergo fibroid induration (syphilitic phthisis). Syphilitic phthisis is often a non-febrile malady. The sputum does not contain the bacilli of tuberculosis, nightsweats and diarrhea are unusual, and emaciation and exhaustion are less decided than in tuberculosis. Gummata may form in the heart, liver, spleen, or kidneys. The capsule and fibrous septa of the liver may thicken, the organ being puckered by contraction. Albuminuria may occur in tertiary syphilis. It may be caused by fibroid changes in the kidneys, by the formation of gummata, or by amyloid degeneration. Its occurrence should be watched for. Mercury and iodid of potassium have been regarded as causative of albuminuria in some cases. When albuminuria is associated with arterial disease and devated tension the condition is to be regarded as parasyphilitic rather than aphilitic. When albuminuria results from a true syphilitic lesion of the kidney, there is enlargement of the liver, that organ is often painful, there is ascites, and sometimes jaundice (Fiessinger).

Syphilis may cause disease of the stomach, and probably does so more irequently than was formerly supposed, because it is difficult to distinguish from more common diseases. The condition may be gummatous infiltration of the walls of the stomach, multiple and minute gummata, ulcerations resulting from breaking down of gummata, or syphilitic endarteritis of the gastric vessels. When ulcers heal, cicatricial contraction results. Sometimes a large mass can be palpated. The symptoms last for years. There is pain after eating, but hemorrhage does not occur unless ulcer forms. Syphilitic

ulcers and gummata of the stomach may be cured by efficient antisyphilitic treatment. Like lesions may form in the intestines. Flexner, Frankel,

Fournier, and others have discussed this subject.\*

Nervous syphilis may be manifested by disorders of the brain, cord, or nerves. It is rare after severe secondaries, and is most common when secondaries were light or so trivial as to have escaped observation. Severe secondaries seem to cast off, mitigate, or exhaust the poison. Nervous syphilis may result directly from the specific disease, and such lesions are truly syphilitic. It may result indirectly from the specific disease, and such lesions are called parasyphilitic. For instance, a gumma of the brain is a true syphilitic lesion, but locomotor ataxia following syphilis is a parasyphilitic lesion. Syphilitic lesions are improved or cured by antisyphilitic treatment, parasyphilitic conditions are not. Brain syphilis is usually a late phenomenon (from one to thirty years after infection). The lesion may be gumma of the membranes (tumor), gummatous meningitis, arterial atheroma, or obliterative endarteritis. A gumma may eventuate in a scar, a cyst, or a calcareous mass. The symptoms of brain syphilis depend on the nature, seat, and rate of development of the lesions. It is to be noted that syphilitic palsy is apt to be limited. progressive, and incomplete. Epilepsy appearing after the thirtieth year is very probably specific if alcohol as a cause can be ruled out. Persistent headache, tremor, insomnia or somnolence, transitory, limited, and erratic palsies, unnatural slowness of utterance, amnesia, vertigo, and epilepsy are very suggestive of syphilis. Sudden ptosis is very significant; so is sudden palsy of one or more of the extrinsic eye-muscles. In syphilitic insomnia the patient cannot get to sleep at night for a long while, but when he once gets to sleep he reposes well. The type of insanity which is most apt to arise is a likeness or counterpart of general paralysis, and, like ordinary paresis, it is not curable. Spinal syphilis may cause sclerosis, a condition like Landry's paralysis, softening, and tumor. Neuritis is not uncommon in syphilis. Many of the diseases which follow syphilis are due to it only indirectly, and are not benefited by specific treatment. Among them are paresis and locomotor ataxia.

Justus's Test for Syphilis.—The test described by Justus, in 1894, consists in first estimating the amount of hemoglobin present, then making a single mercurial inunction, and again estimating the hemoglobin. It is claimed that the corpuscles of an untreated syphilitic are unduly sensitive, and if the disease is present a mercurial inunction will cause a loss of 10 to 20 per cent. of hemoglobin within twenty-four hours, which fall persists a few hours and is then followed by a rise to a level above that which existed when the test was applied. It is often demonstrable in secondary, tertiary, or congenital syphilis. It usually fails in latent cases, when an initial lesion is recent, and in early secondary syphilis, and in some diseases other than syphilis the reaction can be obtained. I regard the test as unreliable. Justus claims that the test is positive in from 70 to 80 per cent. of all cases of florid syphilis ("Deutsch. Arch. f. klin. Med.," 1903, vol. lxxv., p. 1).

The Serum Diagnosis of Syphilis (Wassermann's Test).-This test can only be employed in institutions possessed of the best laboratory facilities. It is technical in the extreme. In order to understand it certain facts must be known.

<sup>\*</sup> See editorial in Jour. Amer. Med. Assoc., March 24, 1900, and Roudnitzky, quoted in Progressive Medicine, June, 1908, from Prakt. Vratch, August and September, 1907.

Every serum contains material known as complement, and complement is destroyed by heat. When bacteria or alien corpuscles are injected into a living animal, the tissues of that animal react and amboceptor is formed. Amboceptor includes all antibodies. Amboceptor is not destroyed by heat. If we inject the corpuscles of sheep's blood into a rabbit, amboceptor forms and appears in the rabbit's serum. Amboceptor unites with complement and with alien corpuscles and the sheep's corpuscles are dissolved. The blood of the rabbit now contains a distinct excess of amboceptor. If some of this blood is drawn and the serum is placed in a test-tube, it will dissolve in the tube corpuscles of sheep's blood if they are added to it. If, however, the rabbit serum is heated for one-half hour to 50° C. before being placed in a test-tube, the heat destroys the complement, and then the rabbit serum will be unable to dissolve the corpuscles of sheep's blood because amboceptor without complement is incapable of effecting solution.

If, however, after destroying the complement by heat, any other serum is added, the added serum furnishes the necessary complement and the mixture is now able to dissolve sheep's corpuscles.

On these facts the serum diagnosis of syphilis depends.

Wassermann proved that if an extract made of a syphilitic organ is placed in the serum of a syphilitic individual, the amboceptor or antibody will unite with the complement and with the organ extract, although the union cannot be recognized by inspection. In order to be able to identify the occurrence of such a union a process must be gone through.

The serum of the patient thought to be syphilitic is heated and complement is thus destroyed. It is then mixed with the organ extract, which unites with the amboceptor of the serum, one arm of the amboceptor being still unsaturated and open for union. Guinea-pig serum is now added to furnish complement. If the patient is syphilitic the serum complement just added will unite with the unsaturated arm of the antibody or amboceptor. To find out if this has taken place we add the heated serum of a rabbit, which will destroy sheep's corpuscles if fresh serum is added to it.

"Sheep's corpuscles are also added. If the complement contained in the guinea-pig serum that was added was taken up or united with by the syphilitic antibody, there will be none left over, and consequently the added sheep's corpuscles will not be dissolved. If, however, the serum was not syphilitic, the complement will not have been taken up, but will be left over for union with the hemolytic amboceptor of the inactivated rabbit serum, which latter unites with the blood-corpuscles, and the combination causes the solution of the latter" (Wm. J. Butler, "N. Y. Med. Journal," Jan. 30, 1909).

Butler made a study of 150 cases and found reaction positive in 123. Ten

Of 36 cases in the secondary stage, 34, or 95 per cent., showed it. Of 31

tases in the secondary stage, 34, or 95 per cent., showed it. Of 31 cases in the tertiary stage, 29, or 94 per cent., showed it. Of 16 latent cases, 4 or 56 per cent., gave a positive reaction. Of 55 cases of parasyphilis and visceal syphilis, 41, or 76 per cent., gave a positive reaction.

Two cases which gave positive reactions failed to give any after active mercurial treatment (Wm. J. Butler, Ibid.).

It is interesting and perhaps important that the test can be made with milk taken from the breast of a nursing mother as well as with her serum.

It seems certain that the serum test has high diagnostic value. A positive reaction indicates that the poison is active and calls upon the physician to apply active treatment. This should be the rule, no matter how long it has been since there were any external manifestations of the disease. Wet nurses should be tested by this method before being allowed to assume charge of an infant. Positive reactions have been obtained in noma and scarlet fever, but neither of these diseases would be confused with syphilis (Wm. J. Butler, Ibid.).

The test seems to prove that syphilis is the cause of paresis and locomotor ataxia. It will probably be much simplified in technic in the near future.

Diagnosis by Finding the Spirochæta Pallida.—This method is of the greatest value. The organism, if carefully searched for, is found in chancre, in all the lesions of early secondary syphilis, and in congenital syphilis. It is not found, it is true, in the gumma, but the gumma is not a contagious

lesion. It is not found in lesions other than syphilis.

Treatment of the Primary Stage.—It has long been taught that a chancre should not be excised because the disease is constitutional when the chancre appears, and excision and cauterization inflict needless pain and do no good. Several observers during recent years have claimed that ablation of the chancre will in some instances prevent the disease. In the reported cases there is some doubt as to the diagnosis and they do not prove the contention. It is very doubtful if ablation is of service. It may be tried if the lesion is on the prepuce and there is no glandular involvement. It should not be tried if ablation requires mutilation. It was shown by Metschnikoff that constitutional syphilis can be prevented by rubbing calomel ointment into the seat of infection within eighteen hours of the intercourse, but prevention of development is not prevention after a chancre forms. This preventive measure is now in use in the U. S. Navy. The ointment used contains 33 parts of calomel, 10 of vaselin, and 67 of lanolin. The initial lesion should never be cauterized unless it is phagedenic or becoming so. Order the patient to soak the penis for five minutes twice daily in warm salt water (a teaspoonful of salt to a cupful of water), and then to spray the sore with peroxid of hydrogen diluted with an equal bulk of water. The ulcer is then dried with absorbent cotton and on it is dusted a powder composed of equal parts of bismuth and calomel. The buboes in the groin require no local treatment unless they tend to suppurate. If they persist or become large, paint them with iodin or rub ichthyol ointment or mercurial ointment into them, and apply a spica bandage to the groin. Some authorities give mercury in this stage in order to prevent secondaries. The younger Gross opposed this strongly, and affirmed a wish to see the secondary eruption-first, because it proves the diagnosis; and, second, because it affords valuable prognostic indications (an erythematous eruption means a light case, an early pustular eruption means a grave case with serious complications); I have always followed the plan of Gross, and do not order mercury until constitutional symptoms develop. If phagedena arises, place the patient at once upon stimulants and nutritious diet, secure sleep, and destroy the ulcer by the use of nitric acid or the cautery while the patient is anesthetized. After cauterization dust the sore with iodoform and dress with wet antiseptic gauze. Several times a day change the dressings, and at each change spray the sore with peroxid of hydrogen, irrigate with bichlorid of mercury solution, and dust with iodoform. It may be necessary to cauterize several times. In some cases it will be necessary to employ continuous irrigation with an antiseptic fluid. These cases are sometimes fatal and usually produce great destruction of tissue. In chancre redux watch carefully for the symptoms in order to determine if the condition is really one of reinfection or if we are dealing with a gumma which resembles a chancre in appearance.

Treatment of the Secondary Stage.—The chance of cure in most cases is excellent if the patient follows advice. The prognosis is much worse if the patient is a hard drinker or is the victim of Bright's disease, diabetes, tuberculosis, or other chronic exhausting malady. In the secondary stage the aim is to cure the disease. That it can be cured is known because reinfection occurs in some persons. The old axiom, "Syphilis once, syphilis ever," is not true.

Diet and General Care. - In the beginning of treatment the patient must see his physician every day or two until the proper dose of mercury has been ascertained. For the following six months he should see his physician once a week, and during the next six months once every other week. During the second year he needs to see him once every month. Of course, if complications arise at any period the visits must be more frequent. At the beginning of the attack he must have his teeth put in perfect order. Tobacco is absolutely forbidden because its use favors the development of mucous patches in the mouth. Alcohol as a beverage is prohibited. It is used only as a medicine. The teeth should be gently scrubbed with a soft brush in the morning, in the evening, and after each meal, and a mild astringent or antiseptic mouthwash and gargle is to be used several times a day. If the gums become red and tender, chlorate of potash is used as a gargle and mouth-wash (1 ounce of the drug to 1 pint of water). The patient should wear flannel in winter. The author believes Guiteras's rules are sound, and in accordance with them directs the patient to refrain from kissing any one on the lips and from using a common towel, wash-rag, cup, glass, pipe, or razor. He is told to sleep alone in bed, to wash his hands often, to wear gloves, and to keep his fingers out of his mouth. Every morning he should take a warm bath, being especially careful to cleanse the anus, perineum, axillæ, groins, and between the toes; and after the bath these parts should be dusted with borated talc powder. A Turkish bath once a week is ordered by Guiteras when no skineruption exists. The patient must avoid drafts, cold and wet; must take a moderate amount of gentle outdoor exercise, and must sleep eight hours out of the twenty-four. The diet is of importance, and in this, too, the author follows Guiteras and orders the patient to avoid eating anything fried, or any meat or fish which has been canned, salted, or preserved. Fruits, pickles, tea, condiments, alcoholic beverages, clams, pork, veal, and pastry are not to be taken. (See article by Luke Begg in "Phila. Med. Jour.," June 7. 1901.)

Medical Treatment.—Mercury must be used, the form being a matter of choice. Fournier advocated intermittent treatment. In this plan give gr. 1 of protiodid of mercury daily for six months, then stop for a month; then give mercury for three months, then stop two months. During the first year the patient is under treatment nine months, and during the second year eight months. Some prefer the intermittent and others the continuous plan

of treatment. The author prefers the continuous plan. In following the continuous plan find the patient's tolerance to mercury, and keep him for two years on daily doses below the amount he will tolerate. Gross's rule for continuous treatment is to order pills of green iodid of mercury, each pill containing gr. 1. The patient is ordered one pill after each meal to begin with; the next day the after-breakfast dose is increased to two pills; the following day the after-dinner dose is two pills, and so on, one pill being added every day. This advance is continued until there is slight diarrhea, griping, a metallic taste, or tenderness on snapping the teeth together, whereupon one pill is taken off each day until all unfavorable symptoms disappear. the dose is reduced one-half and this amount is called the tonic dose. experimentation finds a dose on which the patient can be kept with entire safety for a long time; but if it is found that colic or diarrhea is apt to recur, there must be added to each pill gr.  $\frac{1}{12}$  of opium. The patient is given mercury in this way for two years. Every time new symptoms appear the dose is raised, and as soon as they disappear it is lowered to the standard. If the protiodid is not tolerated, give the bichlorid:

R Hydrarg, chlor. corros., Syr. sarsaparillæ comp., Sig.—f 3, in water, after meals.

gr. j; f Z iij.—M.

Mercury with chalk in 1- or 2-grain doses four times a day, with or without Dover's powder in 1-grain doses, may be used. Mercurial inunctions produce a rapid effect, but irritate the skin. The drug should be rubbed in with a gloved hand. There can be used once a day ½ dram of oleate of mercury (10 per cent.) or 1 dram of mercurial ointment, rubbed into the skin. The first day it is rubbed into the inside of one thigh, the second day into the inside of the other thigh; the third day into the inside of one arm; the fourth day into the other arm; next, into one groin and then into the other groin, and then inunction is again made at the point of original application, and so on. After the rubbing the patient puts on underclothes and goes to bed, and in the morning takes a bath. The ointment may be smeared on a rag, which is then worn between the stocking and sole of the foot during the day.

Fumigation is performed by volatilizing each night 3j of calomel. patient sits naked on a cane-seat chair, and is wrapped up to the neck in a blanket which drops tent-like to the floor; the calomel is put upon an iron plate under the chair, and is heated by an alcohol lamp beneath the plate. The skin becomes coated with calomel, and the subject, after putting on woolen drawers and an undershirt, gets into bed. Hypodermatic injections of mercury are used by some physicians. They cause an eruption to disappear rapidly, but may produce abscesses, and relapses are prone to occur. I agree with Dr. Orville Horwitz that the hypodermatic method will not abort the disease; should never be a routine treatment; in suitable cases it is very valuable for symptomatic use, as when lesions on the face or in important structures make a rapid impression desirable or necessary; in cases which obstinately relapse under other treatment, and in syphilis of the nervous system. J. William White, after a large experience with this method, says that hypodermatic injections of corrosive sublimate are painful and are strongly objected to by many patients; that this method of treatment is occasionally dangerous and even fatal; that it is liable to be followed by local complications (erythema,

nodosities, cellulitis, abscess, sloughing); that it cannot be carried out by the patient, but requires the surgeon's constant intervention. This syphilographer concludes that hypodermatic medication does not offer advantages justifying its use as a systematic method of treatment, and that it encourages insufficient treatment-those "short heroic courses" which Hutchinson shows are followed by the gravest tertiary lesions. "The claim that by a few injections the time of treatment can be measured by months or even by weeks, instead of by years, would seem, as Mauriac has said, to involve the idea that mercury given hypodermatically acquires some new and powerful curative property which, given in other ways, it does not possess." \* The usual plan is to give daily a hypodermatic injection of corrosive sublimate deep into the back or buttock, the dose being gr. 1 of the drug. Thirty such injections are used unless some contraindication demands their discontinuance sooner. The treatment is then stopped. If the symptoms recur, however, the patient is given another course, the daily dosage being gr. 1, the treatment being again stopped after thirty injections, but being continued anew in a grain doses if the symptoms recur. The following preparation is used by some syphilographers: 0.5 of a part of corrosive sublimate, 3 parts of guaiacol, and 97 parts of sterile olive oil. Thirty minims contains gr.  $\frac{1}{16}$  of corrosive sublimate. This mixture should be thrown deeply into the buttock and it causes no pain. The use of gray oil hypodermatically has warm advocates. It is claimed that it provokes but little pain and irritation, and that it is a very efficient remedy. The oil should not be thick like an ointment, because such a preparation could not be used without warming, and heat causes the mercury to aggregate in lumps. Olive oil should not be used, as it becomes rancid. Dumesnil's formula is the best ("Brit. Med. Jour.," Jan. 18, 1908, p. 177):

"The ingredients must be sterilized before they are incorporated, as it is impossible to sterilize the product. If the directions given below are carefully followed no risk of septic poisoning is to be apprehended. The formula proposed by M. Dumesnil has been accepted by a committee especially appointed by the Société de Pharmacie of Paris, to investigate the methods of preparing gray oil. Twenty-six gm. of anhydrous wool-fat and 60 gm. of pure liquid paraffin (huile de vaseline médicinale) are sterilized separately in glass flasks at 120°C. for twenty minutes. A pestle and mortar are sterilized by means of burning alcohol and placed therein are 40 gm. of mercury and then the wool-fat. The metallic particles are triturated until they are sufficiently minute when examined under a magnification of 480 diameters, and then the liquid paraffin is added in small portions. The product should weigh 126 gm. and measure 100 cc. and should be transferred immediately to phials of 2-, 5-, and 10-cc. capacity,

previously sterilized at 180° C."

An injection is given twice during the first week, once during the second week, and after this once a week or once every other week for an indefinite period of time. It may be given oftener if symptoms arise or persist.

Taylor believes that gray oil may give rise to unpleasant and sometimes even dangerous symptoms, and that it should be used with extreme care and only in selected cases in which other remedies are contraindicated. He says that in reading about the hypodermatic method he has been struck with the

J. William White, in Morrow's "System of Genito-urinary Diseases, Syphilology, and Dermatology."

fact that "the most serious results have almost invariably followed injections in which fatty matters have been the vehicle of suspension." \*

Some surgeons employ intravenous injections of mercury. Lane injects, at first every other day and later daily, 20 m, of a 1 per cent. solution of cyanid of mercury. The skin in front of the elbow is rendered aseptic, a fillet is tied around the arm, the needle is inserted into a vein, the fillet is loosened, the fluid is injected, and the needle is withdrawn. This method of using mercury is painless and produces a rapid effect. It may be used in nervous syphilis, but should not be used as a routine. In whatever way mercury is given, do not allow it to produce salivation (hydrargyrism or ptyalism). Always remember that mercury may cause albuminuria and examine the urine at regular intervals during a course of the drug. If albumin appears in the urine, cut down the dose of mercury or stop the drug for a time. In the beginning of a case of syphilis, if the kidneys are found to be diseased, give the mercury cautiously, and never fail to examine the urine at regular intervals. An individual can take more mercury in summer than in winter because during the warm weather perspiration favors elimination.

In order to cure syphilis mercury should be given for two years, and the mercurial course must be followed by at least a six months' course of iodid of potash. Reminders require both iodid of potash and mercury (mixed treatment). Throughout the mercurial course the patient should be weighed once a week, and if it is at any time found that the weight is decreasing, tonics, concentrated food, and cod-liver oil are ordered. If the weight continues to grow less and the health begins obviously to fail, stop the mercury for a time, continue the cod-liver oil, tonics, and nourishing food, and order hot baths, fresh air, iron, and chlorid of gold and sodium. If during the mercurial course albumin appears in the urine and some edema is noted, the mercury should be stopped for several or a number of weeks and the patient should be given a milk diet. If marked albuminuria is noted, but no other symptoms exist, mercury need not be discontinued, but the patient is watched most carefully for the advent of any other symptom (Fiessinger, in "Journal des Practiciens,"

August 3, 1907).

Acute Ptyalism, or Salivation.-In acute ptyalism the saliva becomes thick and excessive in amount; the gums become spongy and tender and liable to bleed. Tenderness is detected early by snapping the teeth. A metallic taste is complained of; the breath becomes fetid; the oral structures swell; the teeth loosen; the saliva is produced in great quantity; and there are purging, colic, and exhaustion. Sometimes there are fever and a diffuse scarlatiniform eruption upon the skin. A chronic hydrargyrism may be shown by salivation, gastro-intestinal disorder, emaciation, mental depression, weakness, albuminuria, and tremor. To avoid salivation, advance the dose with great caution and instruct the patient as to the first signs of the trouble. He should use a soft toothbrush and an astringent mouth-wash (gr. xlviij of boric acid to 3iv each of Listerine and water). When ptyalism is noted, discontinue the administration of the drug. Employ the above mouth-wash or one composed of a saturated solution of chlorate of potassium. Order gr. 120 of atropin twice a day, and in bad cases spray the mouth with peroxid of hydrogen and use silver nitrate locally (gr. xx to 3j). Give stimulants (iron,

<sup>\*&</sup>quot; Venereal Diseases," by Robert W. Taylor.

quinin, and strychnin) and nutritious food. A weekly Turkish bath is of great service. In chronic hydrargyrism stop the administration of the drug, use tonics, stimulants, open-air exercise, Turkish baths, and nutritious food. The chlorid of gold and sodium forms a substitute for mercury. The use of

iodid of potassium is of questionable value in ptyalism.

Treatment of Complications in the Secondary Stage.—The complications of the secondary stage usually require local applications in addition to general remedies. Mucous patches in the mouth should be touched with bluestone every day, an astringent mouth-wash being employed several times daily. If the patches ulcerate, they should be touched once a day with lunar caustic; if these areas proliferate, they should be excised and cauterized. Vegetations or growing papules on the skin must, if calomel powder fails to remove them, be cut away with scissors and be cauterized with chromic acid or with the Paquelin cautery. Condylomata demand washing with ethereal scap several times daily, thorough drying, dusting with equal parts of calomel and subnitrate of bismuth or with borated talcum, and covering with dry bichlorid gauze. If these simple procedures fail, excise and cauterize.

For psoriasis of the palms and soles diachylon ointment, mercurial plaster, or painting with tincture of iodin should be employed. Ulcers of paronychia are dressed with iodoform and corrosive sublimate gauze. Deep cutaneous ulcers are cleaned once a day with ethereal soap, sprayed with peroxid of hydrogen, dressed with iodoform and corrosive sublimate gauze and bandaged. When the process of granulation is well established dress with 1 part of unguent, hydrarg, nitratis to 7 parts of cosmolin. In sarcocele mercurial ointment should be rubbed into the skin of the scrotum or the testicle be strapped. In alopecia the hair should be kept short, and every night the scalp should be cleaned with equal parts of green soap and alcohol rubbed into a lather with water. After the soap has been washed out some hair tonic should be rubbed into the scalp with a sponge. A favorite preparation of Erasmus Wilson's consisted of the following ingredients:

B. Ol. amygd. dil., Liq. ammoniæ, Sp. rosemarini, Aquæ mellis, Ft. lotio.

aā fāj; āa fāij.—M.

One part of tincture of cantharides to 8 parts of castor oil may be rubbed into the scalp. Solutions of quinin are esteemed by some. A useful wash for the scalp is the following: 3j of borate of sodium, 3j of spirits of camphor, 3ij of glycerin, and sufficient orange-flower water to make f3iv.

In treating persistent skin-lesions, inunctions, injections, fumigations, or mercurial baths may be used. Baths are suited to patients with delicate skins, to those whose digestion fails when mercury is given by the mouth, and to those whose lungs will not tolerate fumigations. Half an ounce of corrosive sublimate with 4 scruples of sal ammoniac are mixed in about 4 ounces of water; this is added to a bath at a temperature of 95° F. The patient gets into this bath, covers the tub with a blanket, leaving only his head exposed, and remains in the bath an hour or so. Mercurial baths may rapidly cause salivation.

Tertiary Stage.—If at any time during the case there appear tertiary

symptoms, the patient should be put on mixed treatment. In any case, after two years of mercury add iodid of potassium to the treatment. White's rule is to use mixed treatment for at least six months (if any symptoms appear), the six months' course dating from their disappearance. This emphasizes the fact that the iodids alone will not cure tertiary syphilis. In obstinate tertiary lesions and in nervous syphilis the iodids should be run up to an enormous amount (from 30 to 250 grains per day). Sometimes people can take large doses of iodid when small doses produce iodism. Cvon explains this curious fact as follows: small doses combine with some products of the thyroid gland and form toxic iodo-thyrin. Large doses are diuretic, form soluble salts, and are rapidly eliminated. An easy way to give iodid is to order a saturated solution each drop of which equals about one grain of the drug. Each dose of the iodid is given one hour after meals and in at least half a glass of water. If the iodid disagrees, it may be given in water containing one dram of aromatic spirit of ammonia, or 5 drops of fluidextract of ergot, or it may be given in milk. The iodid of sodium may be tolerated better than the potassium salt, as it is less depressing to the circulation, or the iodids of sodium, potassium, and ammonium may be combined. Gotheil sometimes gives tincture of iodin in 10-drop doses, well diluted. In giving the iodids, begin with a small dose. During a course of the iodid always give tonics and insist on plenty of fresh air. Arsenic given daily tends to prevent skin eruptions. The iodids may disagree for a time, but tolerance may be established as the administration is continued. Iodid can be given as an enema in milk. The value of the newer organic iodin preparations is as yet uncertain. Some of them are given hypodermatically. The iodids when they radically disagree produce iodisma condition which is made manifest by a flow of mucus from the nose, conjunctival irritation, a bad taste in the mouth, exhaustion, anorexia, nausea, and tremor. In some subjects there are outbreaks of acne, vesicular eruptions, or even bullæ or hemorrhages. Iodism calls for the abandonment of the drug, and the administration of increasing doses of Fowler's solution, of arsenic, of laxatives, of diuretic waters, or, if there is great exhaustion, of stimulants. In some cases belladonna is of service. Some patients who cannot take the alkaline iodids may take syrup of hydriodic acid. After the patient has been for six months under mixed treatment without a symptom, stop all treatment and await developments. If during one year no symptoms recur, the patient is probably cured; if symptoms do recur, there must be six months more of treatment and another year of watching. It would be wise were every person who has had syphilis to take a six weeks' course of mercury and iodid twice a year for the balance of life. It is probable that such a plan would save many from visceral syphilis and late nervous syphilis. Syphilitic ulcers are treated locally by cleanliness, antiseptic applications, and, if the situation admits of it, by the daily use of the hot-air apparatus or by the induction of hyperemia by means of the rubber bandage or the cupping-glass. If albuminuria arises during the tertiary stage and there is arterial disease with high tension, mercury will do harm. In albuminuria without high tension, it may be given (p. 323).

The Question of Marriage.—Fournier has insisted that it is a great wrong to tell a syphilitic that he can never marry. He must not marry until he is cured, and he is not cured until, after the cessation of the use of iodid, he goes one year without treatment and without symptoms.

Hereditary Syphilis.—Transmitted congenital syphilis is hereditary syphilis manifest at birth. Acquired syphilis (except in the case of a woman who obtains the disease from a fetus) always presents the chancre as an initial lesion; hereditary syphilis never does. Hereditary syphilis may present itself at birth, and usually shows itself within, at most, the first six months of extra-uterine life. In rare cases (tardy hereditary syphilis) the disease does not become manifest until puberty.

Rules of Inheritance.—According to von Zeissl,\* the rules of inheritance are as follows:

 If one parent is syphilitic at the time of procreation, the child may be syphilitic.

2. Syphilitic parents may bring forth healthy children.

3. If a mother, healthy at procreation, bears a child syphilitic from the father, the mother must have latent pox or must be immune, having become infected through the placental circulation. She often shows no symptoms, having received the poison gradually in the blood, and having thus received, it may be said, preventive inoculations. Certain it is that mothers are almost never infected by suckling their syphilitic children (Colles's law).

4. If both parents were healthy at the time of procreation, and the mother afterward contracts syphilis, the child may become syphilitic, and the earlier in the pregnancy the mother is diseased, the more certain is the child to be tainted. This is known as "infection in utero."

The more recent the parental syphilis, the more certain is infection of the offspring. The children are often stillborn.

6. When the disease is latent in the parents it is apt to be tardy in the

The longer the time which has passed since the disappearance of parental symptoms, the more improbable is infection of the children.

8. In most instances parental syphilis grows weaker, and after the parents beget some tainted children they bring forth healthy ones.

Syphilis in the mother is more dangerous to the offspring than syphilis in the father. The frequent immunity of the mother is due to the fact that her tissues produce antitoxins under the influence of the slowly absorbed virus. The milk of a syphilitic mother contains quantities of antibodies ("Bab. Zeitschrift f. Geb. und Gynäkologie," vol. lx., No. 2).

Many women affected with hereditary syphilis are sterile. Many syphilitic women abort before the eighth month, most commonly in the fifth month. The fetus very often dies at an early period of gestation. This may be due to a gummatous placenta or to a degeneration of placental follicles. Bab (Ibid.) reports that out of 33 infants, victims of congenital syphilis, 16 were born alive and 7 of these died within a few days. Hyde says that about 90 per cent. of those born living subsequently die of the disease.

Evidences of Hereditary Syphilis (manifest at, or oftener soon after, birth).

Hutchinson says that at birth the skin is almost invariably clear. In from six to eight weeks "snuffles" begin, which are soon followed by a skin-eruption, by body-wasting, and by a chain of secondary symptoms (iritis, mucous patches, pains, condylomata, etc.). The child looks like a withered-up old man. Eruptions are met with on the palms and soles. Intertrigo is usual.

Cracks occur at the angles of the mouth, and leave permanent radiating stars. The abdomen is turnid, and there is apt to be exhausting diarrhea. The secreting and absorbing glands of the intestinal tract atrophy.\* It is doubtful if distinct gummatous tumors form in hereditary syphilis. The type of disease induced is a diffuse interstitial cellular change in the viscera, and the viscera are much more apt to suffer than in acquired syphilis. The liver, spleen, and pancreas often enlarge from interstitial changes, and the lungs sometimes are attacked in the same manner. Sometimes synovitis or arthritis arises, the condition being similar to that met with in acquired syphilis. A form encountered between the third month and end of the second year, according to Paton, is characterized by growth into the joint of fungating granulation tissue, the joint is useless, and the parts about are swollen and edematous. Atrophic lesions may appear in the bones. In the skull the bone may be softened by removal of its salts or be thinned by the pressure of the brain. In the long bones the epiphyseal lines suffer, the attachment of the epiphyses to the shafts is weak, and separation is easily induced. Epiphysitis is common, rarely causes pain, and rarely leads to suppuration, except in children who are old enough to walk (Coutts). Osteophytic lesions of the skull are shown by symmetrical spots of thickening upon the parietal and frontal bones (natiform skulls). In the long bones osteophytes are frequently formed. In some cases osteophytes grow from the epiphysis, and in consequence deformity and impaired function are noted and a certain amount of ankylosis may occur. This condition of osteophytic growth from an epiphysis was called by Fournier arthropathie deformant. A child with precocious hereditary syphilis is apt to die, but if it lives from six months to one



Fig. 128.-Hutchinson teeth.

year the symptoms for a time disappear, and for years the disease may be latent. Diagnosis is difficult after the third or fourth year, especially if the disease be associated with rickets or tuberculosis. When later symptoms arise they may be various, namely: noises in the ears, often followed by deai-

ness; interstitial keratitis; synovitis in any joint, particularly painless but marked symmetric effusion in the knee-joints, with trivial functional disturbance; ossifying nodes; developmental osseous defects; suppurative periostitis; ulcerations; death of bone; falling in of the nose; nervous maladies;

occasionally sarcocele, dactylitis, etc.

Dactylitis is common in hereditary syphilis. There is a superficial and a deep form (p. 326). Commonly, a swelling gradually forms. It is fusiform in shape and becomes purple in color. It lasts for months. One or more fingers may be involved and the fingers are more apt to suffer than the toes. The proximal phalanx is most liable to the lesion. The superficial form is apt to soften and ulcerate; the deep form not infrequently causes tissue destruction and shortening of the digit from rarefying osteitis. Some cases of superficial dactylitis are symmetric and of short duration and are to be regarded as late secondary lesions.

In hereditary syphilis the eye symptoms are of great diagnostic importance. In 212 cases of congenital syphilis Fournier found eye trouble in 101.

<sup>\*</sup> Coutts, in Brit. Med. Jour., 1894, 1643.

Keratitis and choroiditis are the most usual forms. Bone trouble occurs in almost half of the cases, but is not often severe enough to cause symptoms. The tongue often shows a smooth base (Virchow's sign). Hirschberg believed choroiditis to be pathognomonic. The descendants of syphilitic parents may exhibit certain pathologic conditions which are not directly syphilitic. Fournier calls such phenomena parasyphilitic. Among these phenomena are arrest of development of the body at large or of special structures, weakness of constitution, and stigmata of degeneration.

Diagnosis.—In the diagnosis of hereditary syphilis the condition of the teeth is of considerable importance: the temporary teeth decay soon, but present no characteristic defect. If the upper permanent central incisors are

examined, they are often, but by no means always, found defective. Other teeth may show defects, but in these alone are characteristic defects likely to appear. In hereditary syphilis they may present an appearance of marked deviation from health, and are then called "Hutchinson teeth" (Fig. 128). If they are dwarfed, too short and too narrow, and if they display a single central cleft in their free edge, then the diagnosis of syphilis is probable. If the



Fig. 129.—Dactylitis.

deft is present and the dwarfing absent, or if the peculiar form of dwarfing be present without any conspicuous cleft, the diagnosis may still be made. The view that teeth of this nature prove the existence of hereditary syphilis and that they occur only in syphilis has been abandoned by Hutchinson himself. In fact, only one-fifth of congenital syphilitics have these teeth, and one-third of the cases of Hutchinson teeth are in individuals free from syphilis. In early infancy the diagnosis of syphilis is made by the snuffles, the broad nose, the skin-eruptions, the wasted appearance, the sores at the mouthangles, the tenderness over bones, condylomata, and the history of the parents. The diagnosis at a later period is made by the existence of symmetrical interstitial keratitis, choroiditis, the smooth base of the tongue, deafness which comes on without pain or running from the ear, ossifying nodes, white radiating scars about the mouth-angles, sunken nose, natiform skull, deformity of long bones, painless inflammation of epiphyses, and Hutchinson teeth. It must be remembered that a child born apparently healthy and presenting no secondary symptoms may show bone-disease, keratitis, or syphilitic deafness at puberty. Finding the spirochæta is of immense importance in arriving at a diagnosis. It is always found unless the organ examined is decomposed or the fetus is macerated. (See article by Wm. S. Gottheil, "Progressive Medicine," Sept., 1908.)

Treatment.—In infants mercurial inunctions are to be used until the symptoms disappear, but mercury must not be forced or be continued too long

after the symptoms are gone. There must be rubbed into the sole of each foot or the palm of each hand 5 grains of mercurial ointment every morning and night. Brodie advised spreading the ointment (in the strength of 3j to the ounce) upon flannel and fastening it around the child's belly. If the skin is so tender that mercury must be administered by the mouth, order that gr. \frac{1}{12} \text{ to } \frac{1}{2} \text{ of mercury with chalk, with 1 grain of sugar, be taken three times a day after nursing. If tertiary symptoms appear, and in any case when the secondaries have passed away, give gr. ss to j or more of iodid of potassium several times a day in syrup. The mixed treatment should be continued intermittently until puberty. Local lesions require local treatment, as in the adult. A syphilitic child should, if possible, be nursed by its mother, as it will poison a healthy nurse, and also because the mother's milk contains antibodies. If the baby has a sore mouth, it must be fed from a bottle, and if the mother cannot nurse the child, it must be brought up on the bottle. For the cachexia use cod-liver oil, iodid of iron, arsenic, and the phosphates.

## XVII. TUMORS OR MORBID GROWTHS.

Division.—Morbid growths are divided into (1) neoplasms and (2)

Neoplasms.—A neoplasm is a pathological new growth which tends to persist independently of the structures in which it lies, and which performs no physiological function. We say that a tumor performs no physiological function in order to make clear that it is never a useful addition to the economy, but we must not imagine that the cells of a tumor are devoid of physiological activity. As Fütterer ("Medicine," March, 1002) has shown, the cells of a carcinoma of the liver may secrete bile, and even the cells of a secondary focus developing in the course of hepatic carcinoma may also secrete bile. cells of a tumor may be active, but this activity is not useful and does not constitute physiological function. A hypertrophy is differentiated from a tumor by the facts that it is a result of increased physiological demands or of local nutritive changes, and that it tends to subside after the withdrawal of the exciting stimulus. Further, a hypertrophy does not destroy the natural contour of a part, while a tumor does. Inflammation has marked symptoms: its swelling does not tend to persist, it terminates in resolution, organization or suppuration, and examination of a section of tissue under the microscope differentiates it from tumor. Inflammation, too, has an assignable exciting cause. A new growth is a mass of newly formed tissue; hence it is improper to designate as tumors those swellings due to extravasation of blood (as in hematocele), or of urine (as in ruptured urethra), to displacement of parts (as in hernia, floating kidney, or dislocation of the liver), or to fluid distention of a natural cavity (as in hydrocele or bursitis).

Classes of Tumors.—There are two classes of tumors; the first class includes those derived from or composed of ordinary connective tissue or of higher structures. These all originate from cells which are developed from the mesoblast. There are two groups of connective-tissue tumors: (a) the typical, innocent or benign, which mimic or imitate some connective tissue of the healthy adult human body; and (b) the atypical or malignant, which

find no counterpart in the healthy adult human body, but rather in the immature connective tissues of the embryo.

The second class of tumors includes those which are derived from or composed of epithelium: (a) the typical, or innocent, composed of adult epithelium; and (b) the atypical, or malignant, composed of embryonic epithelium.

Müller's Law.—Müller's law is that the constituent elements of neoplasms always have their types, counterparts, or close imitations in the tissues, either embryonic or mature, of the human body.

Virchow's Law.—Virchow's law is that the cells of a tumor spring from pre-existing cells. There is no special tumor-cell or cancer-cell.

The starting-point of a tumor is a focus of embryonal cells, which focus may have originated before the person was born or may have resulted after birth from some disease or injury. The nature of the tumor depends first upon the embryonal layer from which it took origin. Connective-tissue tumors spring from the mesoblast; epithelial tumors spring from the epiblast or the hypoblast. The nature of the tumor depends also upon the stage in which the growth of its cells is arrested. If the cells remain embryonal, the growth is regarded as malignant; if they become fully developed, it is regarded as innocent.

The term "heterologous" is no longer used to signify that the cellular elements of a tumor have no counterpart in the healthy organism, but is employed to signify that a tumor deviates from the type of the structure from which it takes its origin (as a chondroma arising from the parotid gland). Tumors when once formed almost invariably increase and persist, though occasionally warts, exostoses, and fatty tumors disappear spontaneously. Tumors may ulcerate, inflame, slough, be infiltrated with blood, or undergo mucoid, calcareous, or fatty degeneration.

Causes.—The causes of tumors are not positively recognized, those alleged being but theories varying in probability and ingenuity.

The inclusion theory of Cohnheim supposes that more embryonic cells exist than are needful to construct the fetal tissues, that masses of them remain in the tissues, and that these embryonic cells may, later in life, be stimulated into active growth perhaps by injury or irritations or hereditary tendency. In other words, Cohnheim believes that all tumors arise from embryonal rells which were included or imprisoned by adult cells during fetal life and were not used during development; or from cells which were "displaced from their proper relations during the process of cell differentiation in the canbryo" (Henry Morris, "Lancet," Dec. 12, 1903). The embryonic hypotheir seems to receive a certain force from the facts that exostoses do sometimes develop from portions of unossified epiphyseal cartilage, and that tumors often arise in regions where there was a suppression of a fetal part, closure of a cleft, or an involution of epithelium (epithelioma is usual at mucoculaneous junctions). This theory does not explain the origin of malignant tumors in scars or recent callus in parts subjected to injury or operation, etc. (Henry Morris).

Durante's addition to Cohnheim's theory does explain them. Cohnheim taught that the matrix from which a tumor springs is always an antenatal embryonic area. Durante says a tumor may also spring from a postnatal embryonic area resulting from injury of the mature tissues, lessening
their activities chemical and physiological (Morris) and causing them to revert
to an embryonic condition.

Objection has been made to the Cohnheim theory on the ground that an embryonal matrix could not remain quiescent, but, as Henry Morris says, certain teeth, the female mammary gland, the larynx, and certain appendages of the skin may not develop until puberty ("Bradshaw Lecture," in "Lancet," Dec. 12, 1903). Branchial cysts which are known to have such an origin are seldom seen until after puberty, and the same is true of many dermoids.

Morris shows that congenital matrices have been shown to exist in the brain, tongue, eye, testicle, ovary, broad ligament, line of coalescence in the trunk and other places, and such matrices constitute *jetal rests* or *vestiges*. The same author shows that post-natal matrices may arise in the healing of a wound or ulcer, fistula, burns, etc. Portions of epithelium are separated, get placed deeply in the newly-forming tissue, become surrounded by connective tissue, and may later take on active growth. As Ribbert points out any

fragment of isolated and imprisoned tissue may become a tumor.

Heredity is an extremely uncertain influence, though not an influence to be denied. I believe that there is such a thing as a more or less complete immunity to cancer and that there is such a thing as a predisposition to cancer, and the predisposition as well as the immunity may be hereditary or acquired. Youth constitutes an almost though not quite certain immunity. Cancer is very rare in youth, and when it does occur in a young person it is always very malignant. Its occurrence means unnatural lack of tissue resistance or unusual vigor of cancer cells. The retrogressive changes of age are predisposing causes. S. W. Gross found hereditary influence by no means frequent in cancer of the breast. It is affirmed by some, denied by others, and doubted by a number. At most, hereditary influence may only predispose. Nevertheless, cases have occurred which cannot be explained by the term coincidence. In the celebrated "Middlesex Hospital case," a woman and five daughters had cancer of the left breast. A. Pearce Gould had charge of a woman for cancer of the left breast. The mother of this patient, the mother's two sisters, and two of the mother's cousins had died of cancer. Power reports a remarkable instance of family predisposition to cancer. A patient had his right breast removed for cancer in 1896. In 1897 cancerous glands were removed from the axilla. In 1808 he was seen again with an irremovable recurrent growth. His father died of cancer of the breast. He had two brothers, one of whom died of cancer of the throat when sixty-five years of age, the other having died of cancer of the axilla when he was only twenty-four years old. Of his eight sisters, four died of cancer of the breast, and the two who are living both suffer from cancer of the breast. sister died when an infant and one died after giving birth to a child.\* The Emperor Napoleon, his father, his brother Lucien, and his sisters Pauline and Caroline died of gastric cancer. That there is such a thing as predisposition is rendered probable by the fact that out of many exposed under like conditions a single one may develop cancer. I believe, with Murphy, that there may be such a thing as absence of resistance to the cause of cancer on the part of certain tissues and that such impairment of resistance may be hereditary.

Injury and inflammation may undoubtedly prove exciting causes. A blow is not infrequently followed by sarcoma; the irritation of a hot pipe-stem

\* Brit. Med. Jour., July 16, 1808.

may excite cancer of the lip; the scratching of a jagged tooth may cause cancer of the tongue; chimney-sweeps' cancer (which used to be seen in the old days when "the sweep" was an institution), arose from the irritation of dirt in the scrotal creases; and warts often arise from constant contact with acrid materials.

Physiologic activity favors the development of sarcoma, and physiologic daline favors the development of carcinoma.

Parasitic Influences.-Many believe that parasites cause cancer. This theory does not maintain that the tumor is the parasite, but that it contains the parasite, although Pfeiffer and Adamciewicz did at one time assert that a cancer-cell is not a body-cell, but a parasite resembling an epithelial cell." Butlin, in 1905, asserted his belief that the cancer-cells are parasites and act independently like protozoa. Most observers deny this contention because, were it true, there would be only one variety of cancer, because cases could only arise by direct contact, and because it would leave unanswered how the original growth arose, as it could not have come from a pre-existing cancer-cell (Brand, in "Lancet," Jan. 11, 1908). Some facts render a parasitic origin of malignant growths not improbable; as, for instance, the likeness of some tumors to infective granulomata, the tendency to secondary development in distant parts of the body, the resemblance of the secondary to the primary growths, and the tenacity of their persistence. A parasitic origin of cancer is possibly suggested by its geographic distribution, the disease being very common in low and marshy districts, and Haviland ("Lancet," April 27, 1894) and others mainthat certain houses become infected, the disease appearing in these houses among successive families inhabiting them. They speak of such abodes as "cancer-houses" (p. 384).

Some surgeons believe that cancer is contagious, but most observers deny it. Hanau found a rat suffering with cancer and inoculated other rats from it. Moreau in 1894 inoculated mice from a mouse with cancer. Guelliott, of Rheims, believes that cancer is primarily a local infection. He believes this because Moreau and Hanau have inoculated it from one animal to another of the same species, and if this can be brought about experimentally he sees no reason why it cannot happen accidentally. This surgeon says that cancer is very unequally distributed, that genuine cancer-centers and "cancerhouses" exist, and that numerous cases of accidental infection have occurred.\* Hahn apparently succeeded in grafting cancer from one part to another on the same individual. Jensen and Borrell have inoculated the disease in white mice. Mayet, of Lyons, holds that cancer can be reproduced by grafting or by injection of cancer-fluid. Graf could not find "cancer-houses" after a careful search.† Geissler claims to have produced the disease in a dog by planting fragments of cancer in the subcutaneous tissue and vaginal tissue, but Czerny, Rosenbach, and others dispute the claim. Plimmer tells us that an epidemic of cancer arose among the captive white rats in the Freiburg Pathological Institute, and in each case the growth was on the rear part of the body. Roswell Park believes that Gaylord has really produced adenocarcinoma in the lower animals. Hauser disputes the assertion that cancer must be an infectious disease because it is followed by secondary growths.

<sup>\*</sup> Amer. Jour. of Med. Sciences, June, 1895. † Archiv. f. klin. Chir., 1995, l., p. 144.

Secondary growths in an infectious disease are caused by the bacterium; secondary growths in cancer are caused by the transference of cells of primary growth.\* Hauser says with truth that the close connection between innocent and malignant growths renders the parasite view untenable, because to hold it we would be forced to believe that every tumor has a special parasite or that one parasite may cause many kinds of tumors.

There seems to be no doubt that autotransference of cancer can occur, although it rarely does so. Sippel has reported a case in which vaginal carcinoma developed at the point where the vagina was in contact with a preexisting cancer of the portio.† Cornil has seen cancer transferred from one of the labia majora to the other, and from one lip to the other. Geissler was unable to transplant cancer, and Gratia also failed in his attempts. Duplay and Bazin say that transmissibility is possible, but only under conditions which are not practically realized. The facts that transplantation can be sometimes carried out, and that contagion is a possible occurrence under exceptional circumstances, do not prove that cancer is a parasitic disease, but simply prove that it can be transplanted. It is not that the cancer carries a parasite which will cause the disease in sound tissues, but rather that the cells of the cancer may themselves take root and grow in sound tissues. The parasitic theory arose from observation of the metastasis which occurs during the progress of the disease, and received support from the fact that inoculation of another part of an individual suffering from cancer may be followed by the development of a tumor like the original growth. For instance, if a cancer is growing upon the lower lip, the upper lip may be inoculated (contact cancer). The same it true of the labia. Mr. Harrison Cripps reported the occurrence of cancer of the skin of the arm from contact with an ulcerating scirrhus of the breast. It has also been pointed out that carcinoma is especially common in regions predisposed by their situation to injury and infection, and that, "among the lower animals at least, tumors resembling carcinomas have been transplanted from one to another" ("Recent Studies upon the Etiology of Carcinoma," by Joseph Sailer, "Phila. Med. Jour.," June 7, 1902). But there is great doubt as to the cancerous nature of some of the tumors which have been successfully transplanted from one animal to another.

A transplanted mouse cancer may grow for a time and then completely disappear, and some observers (among them Gaylord) hold that when this occurs the mouse has become immune.

In 1908 the German Pathological Society met in Kiel and discussed various problems of cancer. In this meeting Sticker maintained that there is such a thing as natural immunity to tumors. He showed that a tumor arising spontaneously in an animal can never be transplanted into an animal of another species, and very seldom can a malignant tumor be transplanted into an animal of the same species. He quotes Metschnikoff's utter failure to transplant human tumors into anthropoid apes and reports his own failure to transplant human tumors into various domestic animals. He made over 400 trials and failed every time ("Jour. Am. Med. Assoc.," from Sticker, "Zeitschr. f. Krebsforschung," 1908, vii.).

<sup>\*</sup> Hauses, in Biolog. Centralbl., Oct. 2, 1895. † Centralbl. f. Gynak., No. 4, 1894.

In successful transplantations there is as yet no proof that epithelial cells were not transferred with the supposed parasites, and if they were transferred the success of the experiment does not prove that cancer is due to parasites, but simply proves again what we knew before—that epithelial cells can be transplanted. Many parasites have been regarded as causative by different observers. Bacteria, yeast-cells, and protozoa have been found by different experimenters. It is not thought that bacteria are causative. Yeasts are regarded as causative by some. It is certain that they may exist in cancer, but it is by no means certain that they cause the disease. They may be only a contamination. Gaylord and others regard the protozoa as causative, but this statement does not seem to be proved. Many of the supposed parasites of cancer have been shown to be cell-degenerations or contaminations. We are justified in concluding that the parasitic origin is not as yet proved, and we agree with the elder Senn that it is improbable.

Tillmanns elaborately discussed the subject of cancer in the Congress of 1895. His conclusions seem most sound and scientific. He says there is no evidence of a bacterial origin of cancer. The parasitic origin has not been proved, and protozoa have not certainly been found. Cancer can be transferred from one part to another of the same individual, or from one individual to another of the same species, but never to one of a different species. It is possible that cancer can spread by contagion; this is very rare, but can happen (as when penile cancer is followed by cervix cancer in a wife). Because it is sometimes possible to transfer cancer, this does not prove that the disease is parasitic or infectious; it simply shows that tissue has been successfully transplanted.

Cancer à deux is cancer developing in people who live together. Such cases suggest but do not prove contagion. Behla collected 19 cases and Guelliot 103 cases. Conjugal cancer is classified as cancer à deux. A wife, for instance, may have cancer of the womb and a husband may develop cancer of the penis, supposedly from contact. Conjugal cancer is probably due to irritation or implantation and not to microbic inoculation.

Actinomycosis, long thought to be a true tumor, is now known to arise from the ray-fungus. Some think that psorosperms cause cancer. There can be no doubt that changes in the liver which practically constitute a new growth can arise from the growth of a cell called by Darier the "psorosperm." A disease due to psorosperms is called a "psorospermosis." It is affirmed by some that molluscum contagiosum, follicular keratosis, cancer, and Paget's disease are due to psorosperms. Some claim to find the parasite in all cases of cancer, while others can find it in only 4 or 5 per cent. of the cases.

Heneage Gibbes affirms\* that dilatation of the bile-ducts of a rabbit's liver is caused by the chronic irritation arising from multiplication of the coccidium oviforme in them, and not in the columnar cells of the bile-ducts, as has been stated; and, further, that the large majority of glandular cancers show nothing that can be considered parasitic, the suspicious appearances noted in some few cases being due to endogenous cell-formation. The coccidium oviforme is a genus of the sporozoa, class protozoa, the lowest division of the animal kingdom. To this case belong the monera and infusoria. (For a further discussion of this subject see page 54).

<sup>\*</sup> Amer. Jour. of Med. Sciences, July, 1893.

Malignant and Innocent Tumors.-Malignant growths infiltrate the tissues as they grow; benign tumors only push the tissues away; hence malignant tumors are not thoroughly encapsuled, while innocent tumors are encapsuled. Malignant tumors grow rapidly; innocent tumors grow slowly. Malignant tumors become adherent to the skin and cause ulceration; innocent tumors rarely adhere and rarely cause ulceration. Many malignant tumors give rise to secondary growths in adjacent lymphatic glands (cancer, except in the esophagus and antrum of Highmore, always does so; sarcoma rarely causes them, unless the growth be melanotic or unless it arises from the testicle or tonsil). Innocent tumors never cause secondary lymphatic involvement; although the glands near the tumor may enlarge from accidental inflammatory complications. The malignant tumors, especially certain sarcomata and soft cancers, may be followed by secondary growths in distant parts and various structures (bones, viscera, brain, muscles, etc.); innocent tumors are not followed by these secondary reproductions, although multiple fatty tumors or multiple lymphomata may exist. Malignant tumors destroy the general health, inducing anemia and cachexia; innocent tumors do not, unless by the accident of position. Malignant tumors tend to recur after removal; innocent tumors do not if operation was thorough. The special histologic feature of a malignant growth is the possession by its cells of a power of reproduction which knows no limit, the cells of the tumor living among the body-cells like a parasite and invading and destroying the body-cells.

The Cachexia of Malignant Disease.—This condition arises sooner or

later in every uncured case of sarcoma and carcinoma.

In sarcoma there is advancing anemia and often episodes of elevated temperature due to the absorption of toxic materials from the tumor. The blood examination gives results similar to those found in cancer, but leukocytosis is more frequent. Pain is far less prominent than in cancer unless a nerve is involved or squeezed. Ulceration occurs much later in sarcoma than in carcinoma.

In carcinoma (p. 379) the emaciation is rapid and decided, the loss of strength is significant and notable, and the anemia is marked and progressive. It is due to pain, sleeplessness, ulceration, impaired appetite and digestion, repeated hemorrhages, and the absorption from the tumor of toxic products (especially isohemolysins). Loss of hemoglobin is early and is followed by decrease in the number of red cells. In many cases considerable amounts of sugar exist in the blood. In both sarcoma and carcinoma the development of secondary growths aggravates the anemia.

Classification.—Tumors may be classified as follows:

I. Connective-tissue tumors (those derived from the mesoblast).

1. Innocent tumors, or those composed of mature connective tissue:

Lipomata, or fatty tumors; fibromata, or fibrous tumors; chondromata, or cartilaginous tumors; osteomata, or bony tumors; odontomata, or tooth-tumors; myxomata, or mucous tumors; myomata, or muscle-tumors; neuromata, or tumors upon nerves; gliomata, or tumors composed of neuroglia; angiomata, or tumors formed of bloodvessels; lymphangiomata, or tumors formed of lymphatic vessels. The term lymphoma, meaning a tumor of a lymphatic gland, was formerly applied to hypertrophy and hyperplasia of a lymphatic

gland, no matter whether caused by syphilis, tubercle, Hodgkin's disease, or any other morbid impression. The term has been largely abandoned except as expressing enlargement of a gland, and does not convey any suggestion as to the cause. It is doubtful if there is such a thing as a true lymphoma, understanding by the term a neoplasm arising from and composed of lymphoid cells and resembling lymphatic structure. In the described cases the possibility of infection as a cause has not been eliminated.

 Malignant tumors, or those composed of embryonic connective tissue: Sarcomata and adrenal tumors.

Endotheliomata are regarded by some as constituting an independent group and by others as a variety of sarcomata.

- II. Epithelial tumors (those derived from the epiblast or hypoblast).
- 1. Innocent tumors, or those composed of mature epithelial tissue:
  - Adenomata, or tumors whose type is a secreting gland; and papillomata, or tumors whose type is found in the papillæ of skin and mucous membranes.
- Malignant tumors, or those composed of embryonic epithelial tissue: Carcinomata, or cancers.
- III. Cystomata are cystic tumors, the cyst-walls of which are new growths and the contents of which are produced by the cells of the newly formed cyst-walls.
- IV. Teratomata (tumors containing epiblastic, hypoblastic, and mesoblastic elements).

Innocent Connective-tissue Tumor.—These growths mimic or imitate some connective tissue or higher tissue of the mature and healthy organism.

Lipomata are congenital or acquired tumors composed of fat contained in the cells of connective tissue, which cells are bound together by fibers. If the fibers are excessively abundant, the growth is spoken of as a fibrojatty tumor. A fatty tumor has a distinct capsule, tightly adherent to surrounding parts, but loosely attached to the tumor; hence enucleation is easy. Fibrous trabeculæ run from the capsule of a subcutaneous lipoma to the skin; hence movement of the integument over the tumor or of the tumor itself causes dimpling of the skin. An ordinary circumscribed lipoma is of doughy softness, is lobulated, of uniform consistence, and on being tapped imparts to the finger a tremor known as pseudofluctuation. A fatty tumor is mobile, although it may be attached to the skin at points by trabeculæ. Lipomata are most frequent in middle life, and their commonest situations are in the subcutaneous tissues, especially of the back or of the dorsal surfaces of the limbs; they usually occur singly, but may be multiple and sometimes symmetrical. Senn described the case of a woman who had a fatty tumor in each axilla. A lipoma may grow to an enormous size (in Rhodius's case the tumor weighed arty pounds), and the growth may be progressive or may be at times stationary and at other times active. The skin over a fatty tumor sometimes atrophies or even ulcerates; the tumor itself may inflame or partly calcify. When a lipoma has once inflamed, it becomes immovable. Subcutaneous lipoma of the palm of the hand or sole of the foot bears some resemblance clinically to a compound ganglion; it is apt to be congenital. Lipomata of the head and face are rare. In the subcutaneous tissues of the groins, neck,

pubes, axillæ, or scrotum a mass of fat may form, unlimited by a capsule and known as a "diffuse lipoma" (Fig. 131). A diffuse lipoma may dip down



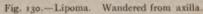




Fig. 131.—Diffuse lipoma.

among the muscles. Such masses attain large size. The typical diffuse lipoma is occasionally seen on the neck. It begins back of the mastoid



Fig. 132.—Lipoma of submaxillary region.

process on one side or on both sides. When large, it completely surrounds the neck, a huge double chin forming in front, a great mass hanging on each side, and the posterior portion being divided into two halves by a median depression. A nevolipoma is a nevus with much fibrofatty tissue. A very vascular fatty tumor is called lipoma telangiectodes. If the tumor stroma contains large veins, the growth is called a cavernous lipoma. A tumor containing much blood can be diminished in size by pressure. Fatty tumors may arise in the subserous tissue, and when such a growth arises in either the femoral or inguinal canal or the linea alba it resembles an omental hernia and is spoken of as a fat-hernia. In the retroperitoneal tissues enormous fibrofatty tumors occasion-

ally grow, and these neoplasms tend to become sarcomatous. Lipomata may arise from beneath synovial membranes and will project into the joints,

being still covered by synovial membrane. Fatty tumors occasionally arise in submucous tissues, between or in muscles, from periosteum, and from the meninges of the spinal cord (J. Bland Sutton). A fatty tumor may undergo metamorphosis. The stroma may be attacked by a myxomatous process or a calcareous degeneration. The fat-cells themselves may become calcareous. Oil-cysts sometimes form. A xanthoma is a growth composed of fatty tissue in and about which there is marked infiltration with small cells. Such a tumor is flattened and slightly elevated. Several or many of these growths occur in the same person. The eyelids are the most common seat of xanthoma. The tumor may undergo involution or may become sarcomatous.

Diabetics are liable to develop xanthomata.

Treatment.—A single subcutaneous lipoma should be extirpated. The capsule must be incised, when the tumor can be torn out forcibly or can be



Fig. 133 .- Fatty tumor.

enucleated by dissection; drainage is always employed for twenty-four hours, as butyric fermentation will be apt to occur, and necrosis of small particles of fat predisposes to infection. Multiple subcutaneous lipomata, if very numerous, should not be interfered with unless troublesome because of their size or situation, when the growth or growths causing trouble should be removed. It is difficult to extirpate entire a diffuse lipoma, and several operations may be needed to effect complete removal. Liquor potassæ, once recommended as possessing power, when taken internally, to limit the growth of multiple lipomata or diffuse lipoma, seems to be useless. Subperitoneal lipomata are rarely diagnosticated until the belly has been opened or the growth has been removed.

Fibromata are tumors composed of bundles of fibrous tissue. There are two forms, the hard and the soft. A hard fibroma consists of wavy fibrous bundles lying in close contact. Here and there connective-tissue corpuscles

exist between the fibers. A fibroma has no distinct capsule, though sur ing tissues are so compressed as to simulate a capsule. Fibromata are sionally congenital, are most usual in young adults, but they may occur period of life, and in any part of the body containing connective tissue. fibromata, which are rare, are generally solitary, grow slowly, are of u consistence, have not much circulation, and are hard and movable. mata may form upon nerves, they may arise in the mammary gland, the develop in the lobe of the ear, and they may spring from various fibrous branes, from the periosteum of the base of the skull (nasopharyngea mata), and from the gums (fibrous epulides). A soft fibroma contains areolar tissue, the spaces of which are filled with fluid, so that the tissue edematous. Soft fibromata grow from the skin, mucous membrane cutaneous tissue, intermuscular planes, and periosteum. Soft fibromata grow from the skin, and of the belly wall of a pregnant woman. They are a simulation of the scrotum, labia, inner sur arm and thigh, and of the belly wall of a pregnant woman.



Fig. 134.-Keloid following a burn.

usually multiple, grow slowly, bu rapidly than the hard fibromat may become quite large and distinct pedicles. Fibromata m come cystic, calcareous, osseou loidal, or sarcomatous, and may in ulcerate, or even become gangrer

A painful subcutaneous to which is a form of fibroma comin females, arises in the subcut cellular tissue, usually of the extre It is firm, very tender, movable, larger than a pea, and the skin seems healthy. Violent pain oc paroxysms and radiates over siderable area, of which the tris the center. These paroxysm occur only once in many days or

times in one day. Pain is always developed by pressure, and may be with spasm. Nerve-fibrillæ are now known to exist in these tubercles which was long denied.

A mole is a fibroma of the skin which is congenital or appears in the weeks of life. It is rounded or flat, is usually pigmented and of a brown is slightly elevated above the cutaneous level, and has a few hairs or and dant crop of hair growing from it, and varies in size from a pin's has several inches in diameter, or may even occupy an extensive area of a lof the trunk. The tumor rarely grows after the thirteenth or fourteent A mole may become malignant, melanotic carcinoma may arise frepithelial structures, or melanotic sarcoma from its connective-tissuments. A mole is an extremely vascular structure; it bleeds freely whor scratched, and it sometimes ulcerates. Occasionally several or many exist in the same individual. If a mole begins to increase rapidly operation is imperative, as rapid growth probably indicates malignant of

Fibrous epulis is a fibroma arising from the gums or periodontal mer

(J. Bland Sutton) in connection with a carious tooth or retained snag; it is covered by mucous membrane, grows slowly, may attain a large size, and sometimes has a stem, but is more often sessile. It may undergo myxomatous change or may become sarcomatous.

Fibrous tumors may arise from the ovary, the intestine, and the larynx. Pure fibromata of the uterus are very rare, but fibromyomata are very common (see Myomata, page 357); hence the term "uterine fibroid" should be abandoned.

Desmoid tumors of the abdominal wall are cellular fibromata. A desmoid tumor has a strong disposition to become sarcoma. It has no real capsule. If takes origin from one of the abdominal muscles of muscular insertions or from fascia, particularly from the rectus muscle or its sheath. In most cases the growth is slow; in some it is rapid and the tumor may attain a great size. It may project either anteriorly or toward the abdomen. This form of tumor is vastly more common in women than in men and is especially common in women who have born children. It may occur at any age, but is most frequent in those between twenty-five and thirty-five. It is a very rare tumor. (See Harvey B. Stone, "Annals of Surgery," August, 1908.)

Molluscum fibrosum is an overgrowth of the fibrous tissue of both the skin and the subcutaneous structure. Senn excludes this form of growth from consideration with fibromata because of its supposed infective origin. It may be limited or widely extended; it may appear as an infinite number of nodules scattered over the entire body or as hanging folds of fibrous tissue in certain areas. Keloid (Fig. 135) is a fibroma of the true skin. It is a hard, fibrous, vascular growth, with a broad base, arising in scar-tissue; it is crossed by pink, white, or discolored ridges, and is named from a fancied likeness to the crab. It has rarely attacked mucous membrane. It is more common in negroes than in whites, and is most frequent in the cicatrices of burns, though it may arise in the scar of any injury, as the scar from piercing the ears, and in the scars of syphilitic lesions, tuberculous processes, smallpox, or vaccination. I believe that the scars of tuberculous lesions and the scars even of ordinary wounds in tuberculous individuals are particularly apt to become beloidal. It is very common in a person with keloid to be able to find some near or distant tuberculous lesion, or a history of former tuberculosis, or the record of the individual having tuberculous tendencies. This would explain the frequency of keloid in negroes. The victim of keloid usually reacts to indexculin. It is not bacteria in the scar, but rather the toxins which I regard as probably responsible. The growth seldom begins in early childhood or in old age. It grows slowly, lasts for many years, and may eventually undergo involution and disappear. It is usually believed that it is almost useless to remove keloid by operation, as it will almost certainly return, yet a study of the growth removed shows no reason for the inevitable return. Charles A. Porter has reported a case of massive keloid of the face and hands notably benefited by many operations and skin-grafting. In this case, Porter says, there has been a gradual but distinct abatement of the tendency to form keloid tissue" (Annals of Surgery, July, 1909). The fibrous tissue of keloid springs from the outer walls of the blood-vessels. The papillæ of the skin above the tumor are destroyed or replaced by fibrous tissue.

Morphea, spontaneous or true keloid, is a name used to designate a growth

of this description which does not arise from a scar; but it seems usual that scar-tissue was present, though possibly in small amount from trivial injury. The fact that keloid is especially common in the negro race (a race presposed to tuberculous) and that it is so frequently met with in the scar of known tuberculous processes, suggests the possibility of a tuberculous case for the condition. The rapid return of keloid after operation suggests a near or distant infection which furnishes material to a point of least restance which causes keloid to redevelop. Some cases of keloid have active tuberculous lesions, others have had them, in still others latent or distant lesions may be found by careful search. In many cases there is a family histay



Fig. 135.-Keloid (case of Dr. L. L. Hill, Montgomery, Ala.).

of tuberculosis. I am at present investigating this important matter. It is certain that the keloid itself does not contain bacteria. Repeated examinations have failed to find them. It is quite possible that the growth contains toxins of tubercle bacilli, the toxins being the irritant cause. I am now seeking to determine if material from keloid introduced into tuberculous animals will cause a reaction, and if a reaction follows the injection of tuberculin into the victims of keloid.

Fibrous and papillomatous growths covered with endothelium may spring from any serous membrane. Such a growth of the choroid plexus calcifies early and constitutes a psammoma or brain-sand tumor. Such tumors are met with not only in the choroid plexus, but also in the conarium and the dura. All psammomata are not fibrous; some are gliomatous and some are endotheliomatous. A cholesteatoma is a fibrous growth covered with endothelium and containing layers of crystalline fat. It occurs especially in the pia mater, but may arise in either of the other membranes or even in the brain substance, and is called a pearl tumor.

tment.—When in accessible regions fibromata should be enucleated.

ta should not be let alone, because any fibrous tumor may become a

If a hard fibroma of the skin exists the skin is incised and the tumor ed out." A soft fibroma is removed by an incision carried round the its pedicle. A painful subcutaneous tubercle should be excised. If hows the slightest disposition to enlarge, or if it is subjected to pressure tion, it should be removed, because if allowed to remain it might into a malignant growth. It is often desirable to remove a hairy or ed mole, not only because it may become malignant, but also because ightly. Fibrous epulis requires the cutting away of the entire mass, oval of the related snag or carious tooth, and sometimes the biting a portion of the alveolus with rongeur forceps. A naso-pharyngeal polyp usually contains sarcomatous elements or becomes a spindleoma. If it has a pedicle, it may be removed by the cautery loop. In case a part of the superior maxillary bone is removed by osteoplastic to permit of extirpation. Keloid should rarely be operated upon: nly return, and will also recur in the stitch holes. Trust to time for on, or use pressure with flexible collodion, by which method J. M. cured a case following smallpox. It may be necessary to operate of ulceration. If it is necessary to operate, remove the keloid and able adjacent tissue and fill the gap with Thiersch grafts. tration of thyroid extract may be of benefit (a gr. v tablet three or four day). This drug must be given cautiously, as it may cause attacks erized by fever, dyspnea, and rapid pulse. Thiosinamin hypodery has been used, it is claimed, with benefit. A 10 per cent. solution and from 10 to 15 minims can be injected into the gluteal muscles rd day. I have seen two keloids cured by the use of the x-rays.

ndromata (enchondromata) are tumors formed either of hvaline of fibrocartilage, or of both. Chondromata are apt to arise from glands, the long bones, the pelvis, the rib cartilages, and the bones of ds or feet, and often spring from unossified portions of epiphyseal They may be single or multiple, and are most commonly met with They have distinct adherent capsules; they grow slowly, and eous origin progressively hollow out the bones by pressure; they cause they impart a sensation of firmness to the touch, unless mucoid ation forms zones of softness or fluctuation; they are inelastic, smooth dar, immovable, and often ossify. A chondroma may grow to an is size. A chondroma of the parotid gland or testicle practically contains sarcomatous elements, and any chondroma may become Chondromata are notably frequent in persons who had rickets life. Eechondroses, which are "small local overgrowths of car-(J. Bland Sutton), arise from articular cartilages, especially of -joint, and from the cartilages of the larynx and nose. Loose or cartilages in the joints may be broken-off ecchondroses or portions e cartilage which are entirely loose or are held by a narrow stalk, and ise by chondrification of villous processes of the synovial membrane; or vast numbers may exist; one joint may be involved, or several; produce no symptoms, but usually produce from time to time violent immobility by acting as a joint-wedge. An ecchondroma may arise

within the medullary canal of a long bone, from foci of dormant cartill may lead to the development of a *solitary cyst* of large size by softenir tumor. The femur is the most usual site of disease. It begins very instand progresses gradually. There are slight lameness, trivial pain, ter below the level of the trochanter, apparent shortening and some but bone. The bone may bend or at some spot may thin so that the cys



Fig. 136.-Multiple osteomata.

felt. Such a bone fractures from slight force, and after a fracture, when the effused blood and inflammatory exudate have been absorbed, a tumor can be distinctly detected. A solitary cyst of a long bone is apt to be regarded clinically as a sarcoma (Bergmann-Virchow).

Treatment.—Remove chondromata whenever possible, for, if allowed to remain undisturbed, they are apt to resent this hospitality by becoming sarcomatous. Incise the capsule and take away the growth, using chisels and gouges if necessary. Incomplete removal means inevitable recurrence. Amputation is very rarely demanded. Loose bodies in the joints, if productive of much annoyance, are to be removed, the joint being opened with the strictest antiseptic care. Amputation is sometimes performed for a solitary cyst of a long bone, the surgeon having looked upon



Fig. 137.—Multiple of Hundreds of them through body.

the growth as sarcomatous. If a correct diagnosis is arrived at, an should be made to remove the cyst without amputation. Bergman ceeded in extirpating such a mass from the femur.

Osteomata.—Osteomata are tumors which are composed of tissue. J. Bland Sutton says that osteomata are ossifying chond Osteomata take origin from bone, cartilage, connective tissue, es

tissue near the bone, serous membrane, and certain glands and organs. Compact esteomata, which are identical in structure with the compact tissue of bone, arise from the frontal sinus, mastoid process, external auditory meatus, and other regions in those beyond middle life; they are small, smooth, round, densely hard, with small and occasionally cartilaginous bases.

Cancellous osteomata, which comprise the great majority of bone-tumors, are similar in structure to cancellous bone. They spring from, and are crusted with, cartilage; they may have fibrous capsules, and are often movable when recent, but soon become fixed; they have broad bases, are angled, nodular, firm (but not so hard as are the compact osteomata), painless except when pressed, occur particularly at the ends of long bones, may grow to large size, and are commonest in youth. Osteomata near joints become overlaid by

burse, which in rare instances communicate with an adjacent joint.

The term exostosis has been used as being synonymous with osteoma, but wrongly so, as an exostosis is an irregular, local, bony growth which does not tend to progress without limit, and which is, hence, not a tumor. A true exostosis is seen in the ossification of a tendon-insertion, in a limited growth from one of the maxillary bones, and in a local growth from the last phalanx of the big toe, which latter form of growth is known as a subungual exostosis. Exostoses of the retrocalcaneal bursa occasionally arise when this bursa is inflamed. Inflammation of this bursa is known as Achillodynia or Albert's disease. The bony masses sometimes found in the brain, lungs, testicle, various glands, and tumors are not true osteomata. Osteomata do not tend to become malignant and do not recur after removal.

Treatment.—Osteomata which are non-productive of pain or trouble do not demand removal. If they produce pain by pressure, if they press upon important structures, if they cause annoying deformities, or if they grow rapidly, then remove them by means of chisels, gouges, or the surgical engine. Subungual exostosis should always be removed. The nail should be split and part of it taken away, and the bony mass be gouged away or be cut off with forceps.

Odontomata \* are tumors composed of tooth-tissue. They spring from the germs of teeth or from developing teeth. J. Bland Sutton divides them into (1) those springing from the follicle; (2) those springing from the papilla;

and (3) those springing from the whole germ.

Epithelial odontomes, or multilocular cystic tumors, arise from the follide, occur oftenest in the lower jaw, dilate the bone, have capsules, and are made up of masses of cysts which are filled with brown fluid. These 1985 are met with most frequently before the age of twenty. Follicular odonlomes, or dentigerous cysts, oftenest spring from the follicles of the permanent molars. In a dentigerous cyst there exists an expanded follicle which distends the bone, the follicle being filled with thick fluid and containing a portion of a tooth. A fibrous odontome is due to thickening of the tooth-sac, which prevents eruption of the tooth; fibrous odontomes are usually multiple, and are apt to occur in rickety children. A cementome is due to enlargement, thickening, and ossification of the capsule, the developing tooth being encased in cement. A compound jollicular odontome is due to ossification of portions

<sup>\*</sup> This section is abridged from J. Bland Sutton's striking chapter upon odontomes in his recent work on "Tumors.

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Novembra is the state of the st Administration of the second constitution of the stance is the new notice of the second state of the immitted confi or the Brain with the the training to the term of thomas the second of the second of the second of the second of or a special material form terms through A PROPERTY OF A TOTAL THE LEGENSTREE FOR THE STATE OF STA The Time of the second second second e in the we are not read . The title is the milities in mittee: www.e.e. Common or a nonema answer commonweal des un de la fille de la compania del compania de la compania del compania de la compania del la compania de la compania del la compania de la compania de la compania del la compania de la compania del la compania A Committee of the committee of the committee of the growth. proceeds to the more construction of the malignant ranges for most lphaThere is the production of the state of the state of the second s They was recommended to the order of the matter in the mat for more than the first one said from the mucius memorane 1994 - Boronia of the afternooning virtuo the military mentus, a enter in the control so so it is the purific and mammary g Then the congenital but the cong Magnetic street which is many sampmatous change). control xy to a control of montrol at transformation we give to it : which is not the control of the unitergoing myxomatous cha of the father of the second and the second angle is a fibromy nom Marine put progress from the mostly memorane of the nose, partie

Treatment.—In treating myxomata, remove them promptly and thoroughly, because of the danger of sarcomatous change. Polyps of the bladder are removed by means of cutting forceps after suprapubic cystotomy has been performed. Nasal polyps may usually be twisted off or be removed by the wire snare or galvanocautery. Occasionally when the growths are numerous and recur rapidly after removal, the inferior turbinated bones should be removed with a saw (Rouge's operation). This operation secures ready access to the area of disease, which can be attacked radically. A very soft myxoma breaks up when removal is attempted, and the base must be cauterized.

Myomata are tumors composed of unstriped muscle-fiber mixed often with fibrous tissue. They are called *liomyomata*. Tumors composed of striated muscle-fiber and spindle-cells are known as *rhabdomyomata*. They are very rare and are always sarcomatous. Liomyomata are found in the womb, in the prostate gland, in the walls of the gullet, vagina, stomach, bladder, and bowel, in the broad ligament, ovary, and round ligament, in the crotum, and in the skin. Myomata usually begin during or after middle age; they are encapsuled, they grow slowly, they are firm and hard, and produce annoyance by their size and weight or by obstructing a viscus or channel. A liomyoma of the posterior portion of the middle of the prostate gland is known as a "middle lobe."

The so-called uterine fibroid is a myoma or fibromyoma. Uterine myomay originate within the walls of the womb (intramural myomata), from the muscular structure of the mucous lining (submucous myomata), or from the muscular tissue of the serous covering (subserous myomata). Intramural uterine myomata may be single or multiple and may grow to an enormous size. Submucous myomata project into the cavity of the womb (fleshy polyps), and may project into the vagina. They distend the uterus and are often accompanied by menorrhagia or metrorrhagia. In some rare cases the projecting tumor is detached by Nature and the patient is cured; in some cases the myoma becomes gangrenous. A fleshy polyp may produce inversion of the lundus of the womb. Subserous uterine myomata cause trouble only by the inconvenience of weight or the discomfort of pressure. Uterine myomata are commonest in single women, and arise most frequently between the ages of twenty-five and forty-five. Negro women are especially prone to develop such tumors. They may never produce any symptoms. Some of these growths, by enlarging until they ascend above the pelvic brim, produce abdominal distention; some become jammed or impacted in the pelvis, and produce by pressure retention of urine, obstruction to the passage of feces or hydronephrosis. Impaction may occur temporarily at each menstrual period. Many myomata produce uterine hemorrhage; some cause retroversion of the womb; some protrude from the cervical canal; some are so large that they cause disastrous pressure upon the colon (obstruction), upon the line veins (great edema), or upon the ureters (hydronephrosis). Uterine myomata usually shrink after the menopause. Pregnancy in a myomatous womb usually ends in abortion. Uterine myomata may undergo fatty, calcareous, or myxomatous change, and may be infected by septic organisms as a result of the use of a uterine sound or of infection of the pedicle after ophorectomy. Infection of a uterine myoma causes great enlargement, therated temperature, sweats, and exhaustion.

The symptoms of myomata of the alimentary canal are similar to or identical with the symptoms of malignant growths. Myomata of the skin are rare growths; they are encapsuled, firm or elastic, and painless.

Treatment.—Cutaneous myomata are removed in the same manner as fibrous tumors. Uterine myomata are treated by rest and the administration of ergot, barium chlorid, and dilute sulphuric acid. If this treatment fails to arrest serious bleeding due to a flesh polyp, dilate the cervical canal and remove the growth. If there be dangerous bleeding in a woman who has some years to wait for the menopause and who has not a removable polyp as the cause, perform oophorectomy in order to bring on an artificial menopause. When a myoma becomes impacted at each menstrual period, remove the ovaries and Fallopian tubes. Subserous myomata may be removed from the uterus after abdominal section, the resulting wound in the uterus being sutured. Hysterectomy is indicated for some very large tumors, for tumors that grow after the menopause, and for infected myomata. If the abdomen be opened to perform oöphorectomy, and the tubes and ovaries are found so implicated in the growth that they cannot be removed completely, or the broad ligament is found so drawn out that a safe pedicle cannot be secured, perform a hysterectomy.\* A recent suggestion for the shrinkage of uterine myomata is to ligate both the uterine and ovarian arteries. If a myoma of the prostate causes severe obstruction, perform a suprapubic cystotomy and remove the major portion of the enlarged gland; or make both a suprapubic and a perineal opening, push the gland into the perineum and shell it out with the finger, or make permanent suprapubic drainage.

Neuromata.—A true neuroma springs from nerve-tissue (brain, cord, or nerve-trunks); it is composed of medullated or non-medullated nerve-fibers which form a plexus or network, and which are not continuous with the fibers of the nerve-trunk or other area from which the tumor grows. True neuromata, which are rare growths, arise during middle life; they are small in size; are due to injury or hereditary tendency, and they may be single or multiple. There is usually around the tumor, rather than in it, severe neuralgic pain, which is greatly intensified by dampness, by blows, or by rough handling. The parts below a neuroma are cold, swollen, often anesthetic, and frequently present motor paralysis or trophic disorder. A false neuroma or neurofibroma is a fibrous tumor growing from a nerve-sheath, and is identical in structure with the sheath. False neuromata may be single, but they are often multiple; they may be as small as peas or as large as oranges; they are smooth and movable, and may cause great pain or may be painful only when pressed or struck; they may spring from roots, trunks, or branches, and they may be linked with the disease known as "molluscum fibrosum." In plexiform neuroma some branches of a nerve enlarge and lengthen like an artery in a cirsoid aneurysm; the mass feels like beads or like a bag of worms; it is mobile, and no pain is felt on moving it; and it is generally congenital. In plexiform neuroma the nerve-sheath undergoes myxomatous change. Malignant neuroma is a primary sarcoma of a nerve-sheath, though any neuroma may become sarcomatous.

Traumatic neuromata are false neuromata and are occasionally well ex\*See J. Bland Sutton's admirable article on "Uterine Myomata" in his work on
"Tumors."

hibited after nerve-section or amputation. On nerve-section the distal end shrinks and atrophies, the proximal end enlarges and becomes bulbous. A traumatic neuroma is composed of fibrous tissue which contains nerve-fibers. Such a growth is usually, but not always, painful on pressure or during dampness, and is most commonly seen in a stump which did not heal by first intention. In performing an amputation cut the nerves high up, and thus keep them out of the scar, permit them to remain mobile in their sheaths, and so prevent a tender stump. A tender stump may be due to anchoring of a nerve in a scar, the nerve ceasing to glide when the individual moves the extremity. The condition known as painful subcutaneous tubercle was discussed on page

Treatment.-A false neuroma is to be removed, if possible, without destroying the nerve-trunk. If, in removing a neuroma, it is necessary to exsect a portion of a nerve-trunk, always endeavor to suture the ends of the divided nerve so as to facilitate restoration of function. For multiple neuromata-at least should the number be large or should molluscum fibrosum exist-surgery can do nothing. Plexiform neuromata may often be removed, but amputation may be required. Painful neuromata in stumps should be excised.

Gliomata.—These tumors develop from neuroglia and more often from the white substance than from the gray. They are usually single, and arise in the brain, rarely in the cord, and very rarely in the cranial nerves. They may take origin in one of the cerebral hemispheres, in the cerebellum, in the pons, or in the medulla. Some gliomata are soft and bear a close relationship

to sarcoma; others are hard and resemble fibroma.

A glioma is a circumscribed growth in contrast to a gliosis, which is a widespread and unlimited hyperplasia of the neuroglia. Syringomyelia is due to gliosis of the spinal cord.

"A glioma consists of cells containing rounded or oval nuclei with very little protoplasm and fine protoplasmic extensions which interlace and form

an intercellular reticulum" (Stengel).

A glioma passes almost insensibly into surrounding tissue, and there is no distinct edge; hence, because of the slight differentiation from brain substance, it may be overlooked during exploration. It is harder than the surrounding tissue; is vascular and of a pink or red color; and the normal shape of the part is often very little altered, although the tumor may reach the size of a lemon.

Hemorrhage may take place into a glioma, softening may occur, cavities may form, or the growth may become sarcomatous or psammomatous. The symptoms of a glioma of the brain depend on the situation.

Treatment.—When the growth can be localized it is justifiable in some cases to attempt its removal. Even a partial removal may be of benefit.

Angiomata or Hemangiomata.—An angioma is a tumor composed largely of dilated blood-vessels. The older surgeons called such growths tractile lumors. Some of the so-called angiomata are not genuine new growths,

but are due to dilatation and elongation of blood-vessels.

Simple or capillary angiomata, nevi, or "mother's marks," which affect the skin or subcutaneous tissue, are composed of enlarged and twisted apillaries and of anastomosing vessels surrounded by fat. These growths are congenital or appear in the first few weeks of life; they are flat and slightly raised, and are of a bright-pink color if composed chiefly of arterioles, and are bluish if composed mainly of venules; they are but little elevated; they can be almost completely emptied by pressure; they occasionally pass away spontaneously, but usually grow constantly and may become cavernous; they may ulcerate and occasion violent or fatal hemorrhage. One or several large vessels connect a nevus to adjacent blood-vessels. Port-wine or claret stains are pink or blue discolorations due to superficial nevi of the skin; they may be small in extent or they may involve a very large area, are not elevated, and do not usually spread. Telangiectasis is a form of nevus involving the skin and subcutaneous tissue in which many arterioles and venules exist. Simple angiomata are common on the forehead, the scalp, the face, the neck, the back, and the extremities. They may appear on the labia, the tongue, or the lips.

Cavernous angiomata, or venous nevi (Fig. 138), resemble in structure corpora cavernosa of the penis; there are large endothelial lined spaces with thin walls carrying blood, and there may be distinct vessels as well. Arteries send blood into the spaces, and veins receive it from the spaces. These channels and sinuses are enormously distended capillaries. Cavernous



Fig. 138.—Dr. Hansell's case of cavernous angioma of the eyelids.



Fig. 139.—Cavernous angioma of face-

angiomata arise in the shin and subcutaneous tissues; they are usually congenital, but may develop from simple angiomata; they are purple or blue in color; are more distinctly elevated than the capillary nevi; may be either cutaneous or subcutaneous; swell when the child cries, and are apt to pulsate; they may be emptied by pressure, and often look like cysts with very thin walls. Cavernous angiomata may arise in the breast, the tongue, the lip, the cheek, the gums, the subcutaneous tissues, or the muscles. If an angioma contains an excess of fat, the growth is called a "nevoid lipoma."

Plexiform angiomata are known as "cirsoid aneurysms" or aneurysms by anastomosis (page 432).

Angiomata noticed soon after birth may disappear completely or may enlarge progressively.

Treatment.—These growths if large or growing must be treated. A capillary nevus can often be quickly cured by touching it with fuming nitric acid. A second application of acid may be required. The growth may be destroyed by heat—"a knitting-needle at a dull-red heat or the galvanocautery" (Wharton). The application of ethylate of sodium or the employment of electrolysis will destroy the growth. Astringent injections are dangerous unless the base of the nevus is ligated, because they may lead to the formation of emboli.

Small port-wine stains may be removed by electrolysis or multiple incisions, but extensive stains are ineffaceable. Small nevi may be ligated under harelip



Fig. 140.—Cavernous angioma: Subcutaneous tissue of leg.

pins, larger nevi may be strangulated in sections by the Erichsen suture (Fig. 141), or may be completely excised. Excision is usually the best plan for the cure of angiomata. It is rapid, thorough, and leaves but a trivial scar. Excision should always be employed if we feel sure that the edges of the wound can be subsequently approximated and that there will not be a dangerous loss of blood. It is sometimes justifiable to excise an angioma even when approximation of

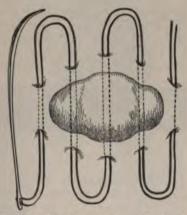


Fig. 141.—Method of applying Erichsen's ligature.

the wound will obviously be impossible. In such a case the raw surface should be covered with Thiersch grafts.

Most superficial nevi and many cavernous angiomata can be treated by excision. The incisions must be beyond the dilated vessels. In large angiomata involving the skin and also deeper parts, or involving a structure, like the lip, which it is undesirable to remove, electrolysis should be employed. The operation should be carried out with aseptic care and, if the tumor is large, an anesthetic should be given.

The positive pole produces a firm and hard clot. One or more no connected with the positive pole are inserted into the tumor, the no being insulated to within about a quarter of an inch of their points. I moist pad is placed upon the skin near the tumor and is attached to the tive pole, and the pad is moved from time to time during the operation

From twenty-five to seventy-five milliampères is the proper strength the current is passed for ten minutes. The current is increased for a mo

Fig. 142.—Cavernous angioma and lymphangioma.

before withdrawing the needles, of wise they will stick to the tissue cause bleeding when torn loose, the withdrawal of the needles the right will be found to be hard, but hardness will gradually disappear may be necessary to repeat the ortion a number of times at intervaten days.\*



Fig. 143.—Cavernous angioma, lymphan and lymphangiectasis, also beginning ca

Lymphangiomata are tumors composed of dilated lymph-vessel are often, though not invariably, congenital (Fig. 143). A lymphatic is a colorless or faintly pink elevation; if it is punctured with a needle, I flows from the puncture. One or several nevi may be present in the individual. The dilatation is due to blocking of the lymph-channels. lymphangioma of the tongue is manifested by a cluster of papillary pi tions containing lymph. Macroglossia is a congenital enlargement of th terior portion of the tongue, which enlargement grows more and more ma until finally the tongue is forced far out of the mouth. This condition of the enlargement is due to lymphangioma of the mucous membrane. L scrotum is due to a similar growth. A collection of these warty-looking tations is called lymphangiectasis. Just as cavernous angiomata cons

\* Chevne and Burghard's "Manual of Surgical Treatment."

a variety of blood-vessel tumors, so cavernous lymphangiomata constitute a variety of lymph-vessel tumors, and the spaces of the latter are filled with lymph instead of with blood. Areas affected with lymphangiectasis are liable to repeated attacks of erysipelas-like inflammation. Whether this inflammation is causative or secondary is not known. In tropical countries blocking of lymph-channels may be brought about by the filaria sanguinis hominis, a parasite which lurks in the lymph-vessels during the day and is found in the blood only at night. Lymphangiectasis is often the first stage of elephantiasis.

Treatment.—A lymphatic nevus requires excision. In macroglossia the bulk of the mass should be removed by a V-shaped cut, the mucous membrane being sutured so as to cover the stump. In conditions due to the filaria, anilin-blue has been given internally.

Malignant Connective-tissue Tumors, or Sarcomata.—The sarco-

mata are composed of embryonic tissue-cells, the intercellular substance being very scanty and they resemble a process of chronic inflammation. They develop from connective tissue, rarely have a definite stroma, and the constituent cells, as a rule, proliferate with great rapidity. If a sarcoma has a stroma of connective tissue, this stroma contains lymphatics and such a sarcoma infects adjacent glands. In most cases there is no connective-tissue stroma and molymphatics. In a sarcoma without a definite stroma the blood-vessels are not surrounded by lymph-spaces and are quickly invaded by cells (B. H. Buxton). The rapidly growing forms are very vascular, the blood flowing in ressels whose walls are very thin or running in canals lined by endothelium and bounded by sarcomatous cells. Such a tumor may pulsate and have a

Softsarcoma with duskyskin above it (Fig. 145) may be mistaken for an abscess. Aslow-growing sarcoma has but few vessels. Sarcoma tends strongly to infiltate adjacent parts. The growth disseminates by means of the blood and the vessel-walls, particles of the tumor being carried by the venous blood to the

bruit, and hemorrhage often takes place into its substance. A rapidly-growing

heart and from this organ to the lungs, where they lodge and form scondary growths. Emboli from these secondary foci are sent out by the arterial blood to various portions of the body, as the bones, kidneys, brain, liver, etc. This process is known as "melastasis." In some ases sarcoma is disseminated widely throughout the body, almost all the tasues showing minute white spots of secondary sarcoma which resemble tubercles. Such widespread dissemination is called sarcomatosis. Summa follows the vein-walls for considerable distances and builds elongated masses of tumor-substance inside the veins. The tumor may



Fig. 144.-Sarcoma of the antrum,

possess a capsule when it is in an early stage, but soon loses this except in very slow-growing varieties or in mixed forms growing by central proliferation,



Fig. 145.-Small round-celled fungating sarcoma of neck.



Fig. 146.-Small round-celled sarcoma of neck. Skin has given way and a bleeding mass is expos

but secondary sarcomata are often encapsuled. Sarcomata may arise at any age from birth to extreme senility, but they are commonest during youth and early middle age. They are not hereditary, and often follow traumatism and inflammation. A number of observers maintain that they are due to parasits (the question of the parasitic origin of malignant disease is discussed on page 343). A sarcoma may be primary or may arise from malignant change in an innocent connective-tissue growth (chondrosarcoma, fibrosarcoma, etc.). A sarcoma rarely affects adjacent lymphatic glands unless it contains lymphatics, and the great majority of sarcomata do not contain them. Occasionally sarcoma-cells are carried to adjacent glands by the ven-walls rather than by the lymph-stream. Sarcoma of the tonsil, sarcoma of the testicle, melanotic sarcoma, and lymphosarcoma do affect the glands. The skin over the tumor may give way, a bleeding fungus-mass protruding imagus hæmatodes) (Figs. 145, 146, and 147), and suppuration may cause septic

enlargement of adjacent glands After removal of a sarcoma the growth tends to recur, and the recurrent tumor may be either more or less malignant than its predecessor, the degree of malignancy being in direct ratio to the number and smallness of the cells. A sarcoma is malignant by local tissue-infection and by dissemination, Sarcomata rarely cause pain when they are not ulcerated. They are commonest in the skin and connective tissue of the extremities, but they arise also from bone, neuroglia, periosteum, the lymphatic glands, the breast. the testicle, the eyeball, the parotid, and other parts. Not unusually



Fig. 147.-Sarcoma of neck (Horwitz).

a pigmented mole becomes sarcomatous. Hemorrhages into a sarcoma often occur, with the result of suddenly increasing the size of the mass and formation of blood-cysts. Sarcomata are subject to partial fatty degeneration, to myomatous changes which produce cavities filled with fluid, to calcification, and occasionally to necrosis of large masses.

Varieties of Sarcomata.—The following species of sarcomata are recognized:

1. Round-celled sarcoma is a tumor composed of round or spherical cells and resembling a chronic inflammatory area. The intercellular substance is scarty, the mass is soft and vascular, and grows with great rapidity. It often softens, and may become cystic. The cells may be small or large. The smaller the cells the more malignant the growth. A growth composed of small round cells is the most malignant form of sarcoma (Fig. 150). Lymthosarcoma is a form of round-celled sarcoma which arises from lymphatic glands, lymphoid tissues, the thymus gland, the spleen, and some other structures. The structure of a lymphosarcoma resembles the structure of



Fig. 148.-Dr. W. R. Bishop's case of small-celled sarcoma of the antrum.



Fig. 149.—Osteosarcoma of eighteen mouths' standing of right side of superior maxilla. Note be lump on left side of lower jaw.

a lymph-gland in the fact that it has a reticulum which looks like lymphadenoid structure. *Chloroma* is a form of lymphosarcoma arising particularly from the periosteum of the bones of the cranium and face. The cells contain



Fig. 150.-Small round-celled sarcoma of the neck.

greenish pigment, hence the name. What is known as glioma of the eyeball is not a true glioma, but is really a sarcoma composed of small round cells.

2. Spindle-celled sarcoma is a tumor composed of large or small spindle-shaped cells lying in a matrix, which may be homogeneous, but which may show some attempt at fiber formation. Angular cells and stellate cells are

often present. The cells may be placed in columns, which are at some places nearly parallel, and which at others diverge or interlace. Often there is no orderly arrangement. Spindle-celled sarcomata are usually harder than tound-celled growths, but are sometimes quite soft. Cystic thanges may occur. If there is a large amount of interrellular substance the growth is known as a fibrosarcoma. spindle-cell sarcoma containing striated muscle-cells. The



A rhabdomyoma is really a Fig. 151.—Spindle-celled sarcoma of sheath of flexor spindle-cell sarcoma contain-

spindle-cell sarcomata often contain cartilage. Spindle-cell growths are by no means as malignant as round-cell tumors. Often they do not show any tendency to metastasis. The greater the amount of intercellular substance and the fewer the cells, the less the malignancy. Bloodgood points out

that in one group of cases (the least malignant) the spindle cells exhibit a disposition to form fibroblasts (fibrospindle-cell sarcoma). In another group (the most malignant) there are no fibroblasts and round cells are distributed among the spindle cells (mixed spindle-cell and round-cell sarcoma). Spindle-cell growths constitute the majority of sarcomata met with in practice.

3. Giant-cell, myeloid, or medullary sarcoma is characterized by the presence of numerous very large cells, with many nuclei looking exactly like the myeloplaques of bone-marrow. Such a growth is maroon colored on section. It arises usually from bone, especially from the interior of a long bone, hence is often called osteosarcoma. It is almost invariably single, but Rehn reported a case of multiple giant-cell sarcoma of bone, and Crile and Hill reported another. It may, however, arise from other structures than bones It is the least malignant form of sarcoma. Metastases do not occur and the



Fig. 152.-Melanotic sarcoma.

growth often admits of complete extirpation and cure. Some surgeons do not class these growths with sarcomata. Bloodgood regards their malignancy as very slight. Friedlander looks upon them as benign angeiomata in which giant cells have been formed by endothelial cells budding into spaces lined with endothelium.

4. Alveolar Sarcoma.—Alveolar sarcoma is a tumor containing both round-cells and spindle-cells, and characterized by the formation of acini, filled with round-cells of large size resembling epithelioid cells. The walls of the acini are formed of spindle-cells and fibrous tissue, and in these trabeculi are the blood-vessels. The collection of the cells in the alveoli makes the structure resemble that of a cancer. Such growths are often pigmented. Alveolar sarcomata arise particularly from moles of the skin, but may arise from lymphatic glands, serous membranes, the testicle, and other parts. Such growths are very malignant.

5. Melanotic or Black Sarcoma (Fig. 152).—The color of such a tumor is due to pigment in the cells or matrix. These growths are usually camposed of round cells, but may consist of spindle cells, and they are sometimes alveolar. Melanotic sarcomata spring from parts which contain pigment (for instance, the skin and the choroid coat of the eye); they are very malignant; they implicate related lymphatic glands, undergo early metastasis, and during their existence the urine contains pigment.

Malignant growth from a congenital pigmented mole used to be regarded as melanotic sarcoma, but Bloodgood would place these growths in a group by themselves. He says that the weight of opinion is on the side of those who



Fig. 153.-Dr. Hansell's case of cystic myxosarcoma of the orbit.

maintain that the cells are of epithelial origin misplaced early in embryonic life, and that the tumor is a cancer. Many surgeons still regard such a tumor

 Hemorrhagic sarcoma is a sarcoma containing blood-cysts which result from parenchymatous hemorrhages.

7. Angeiosarcoma or hemangeiosarcoma takes origin from the outer coat of a blood-vessel. The growth is often very vascular, and when the blood-vessels are notably dilated the tumor is called a telangiectatic sarcoma. The ordinary forms of angeiosarcoma are only moderately malignant, but alveolar and melanotic forms occur which are highly malignant. Angeiosarcoma may arise in the skin, in a serous membrane, in intermuscular structure, in bone, or in a alway gland. It most frequently takes origin from a nevus.

8. Cylindroma, or Plexiform Sarcoma.—In this variety the cells ad to vessels have undergone hyaline or myxomatous degeneration; the distant from vessels are unchanged. Section shows the normal cells a ently contained in spaces with hyaline walls. These degenerative choccur most often in the angiosarcomata. Cylindromata arise from the salivary glands, lachrymal glands, and rarely from the subcutaneous. The growths are only moderately malignant.\*

 Mixed tumors consist partly of mature and partly of embryonic the cellular elements exceeding the adult elements in amount. Among mixed tumors are fibrosarcoma or the recurrent fibroid tumor, myxosa

(Fig. 153), chondrosarcoma, gliosarcoma, and osteosarcoma.

ro. Endotheliomata are tumors springing from endothelium, and the is retained no matter what change the growth ultimately undergoes. writers include under the term endothelioma psammoma, myxosar angiosarcoma, and plexiform sarcoma. Others consider endothelio special and characteristic form of sarcoma. Some would not consider the sarcomata at all. The growth may take origin from the "enlium of the blood-vessels and of the perivascular lymph-spaces, of the lyvessels, and of the great serous cavities (peritoneum, pleura, mening The characteristic cell is the endothelial cell, usually known as the elioid cell. The structure of these tumors is very variable and depends the origin. Some tumors "recalling the original vascular network" ("ican Text-Book of Pathology"), others being distinctly alveolar. pathologists consider a psammoma of the dura to be an endothelioma fibrous stroma. A psammoma contains calcareous particles. In a



Fig. 154.—Recurrent sarcoma of the sternum.

ance an endothelioma st resembles cancer, and s growth is often spoke as endothelial cancer. growths can arise in man ferent situations, but are ticularly common in the toneum, pleural memi membranes of the brain, and testicle. I have ren an endothelioma of the one of the mammary glan of the nasopharynx, and of the carotid gland. The liferating endothelial cells lymph-spaces. Many end liomata grow rapidly, se ary growths form, and

tases are apt to pass to the serous membranes. Certain endotheliomata slowly, do not infiltrate adjacent structure, and do not produce seco growths. In the brain and cord endothelioma may produce no symptoma long time. It is not as yet possible, clinically, to distinctly recognize theliomata from ordinary sarcomata.

\* Stengel, "Text-Book of Pathology."

<sup>† &</sup>quot;An American Text-Book of Pathology," edited by Hektoen and Riesman

tt. Mycosis fungoides is a disease which resembles sarcoma in many particulars and may perhaps be a form of sarcoma. It attacks the skin and subcutaneous tissues. The skin at first becomes red and swollen; numerous nodules form; the nodules become distinct tumors, soften at their centers, and fungation occurs. Microscopically the tumor resembles a lymphadenoma. Mycosis fungoides is considered by some pathologists to be multiple cutaneous sarcoma.

Treatment of Sarcomata.—Remove a sarcoma at once if it is in an accessible spot. Never delay removal. Cut well clear of it. If affecting a



Fig. 155.—Central sarcoma of the 6bula.

land where amputation is impossible, the rapidly growing sarcomata will almost inevitably return, and the very malignant variety, if uninterfered with, may terminate life in six months; but even in such case operation postpones the evil day and renders it possible that death will occur from metastatic mouth in an organ, and that the patient will escape the horrors of ulceration and hemorrhage from the original tumor. Slowly growing and hard tumors offer some prospects of cure. The mixed tumor (as a recurrent fibroid) may receivedly recur, and yet the patient may be cured at last by a sixth, an righth, or a tenth operation. In a case of spindle-cell sarcoma of the breast the younger Gross performed 22 operations in the course of four years, and deven years later the woman was well. In a case of recurrent fibroid of

the neck, the younger Gross operated five times. Three years after Prof. Gross's death I operated upon the same patient, and again two years later. Nine years after the last operation she was alive and well. In sarcoma of a long bone (though not in giant-cell sarcoma) amputation should, as a rule, be performed, although Bloodgood proves that in many of these cases extensive excision is just as useful. In giant-cell sarcoma incision and curetting may be employed or, if this is insufficient, subperiosteal excision. Bloodgood has reported the cases of giant-cell sarcoma from Halsted's clinic. The reports show that excellent results follow this plan of treatment. If the soft parts are involved, they must be removed wide of the growth. Amputation is necessary only when the removal of soft parts must be so extensive as to hopelessly mutilate the limb. In sarcoma of either jaw-bone, excision; of the eye, enucleation;



Fig. 156.—Inoperable sarcoma of the back.

of the testicle, castration is demanded. Sarcoma of the ovary in adults demands removal, but in children the operation is generally useless. Sarcoma of the kidney in adults calls for nephrectomy, but in children the operation is usually of little avail. In my experience, in the cases of sarcoma of the kidney which survived operation, the growth always appeared in the other kidney. In melanotic sarcoma extirpate the growth widely and remove anatomically related lymph-nodes, or in some cases amputate far away from the tumor and remove lymph-nodes. In very malignant sarcoma even amputation does not often cure. Removal of a sarcoma when there is no hope of a cure is often justifiable to prolong life, to relieve the patient of a foul, offensive, bleeding mass, and to permit of an easier road to death by means of metastasis to an internal organ. In an inoperable case the ligation of the vessel of supply may do good. In sarcoma of the tonsil Dawbarn advises the extirpation of the external carotid artery and the ligation of its branches. The operation is per-

formed first on one side of the tumor and in a week or so on the other side. I employed it in 5 cases with distinct but temporary benefit. Occasionally, though very rarely, suppuration cures a sarcoma. Wyeth, of New York, reported a case of sarcoma of the abdominal wall. It was found possible to remove only part of the growth; suppuration followed and the tumor disappeared, and ten years later had not returned. A study of statistics seems to indicate that more cases of sarcoma are cured after operation if the wound suppurates than if it remains aseptic, and it has been proposed to deliberately infect the wound with pus germs to lessen the danger of recurrence. If the wound is large, it should not be infected until it is nearly healed. If it is small, it may be infected at the time of operation or soon after. After amputating for sarcoma, Wyeth waits until the wound is nearly healed and then infects it by inserting a gauze drain saturated with cultures of pure streptococcus pyogenes (Wyeth's "Surgery"). After removing a sarcoma in any region, the patient should be given courses of injections of Coley's fluid (see below).

It has been observed that an attack of erysipelas occasionally greatly benefits a sarcoma, causing large masses of the growth to soften or to slough and exposing a granulating surface. Busch noticed this in 1866, but the fact had been observed in the seventeenth century. Interest was decidedly awakened by Billroth's case of sarcoma of the pharvnx which was cured by an attack of facial erysipelas. It was suggested that in inoperable cases of sarcoma erysipelas might be established artificially. Fehleisen inoculated tumors with cultures of erysipelas. Lassar, in 1891, employed the toxins (cultures rendered sterile by heat and filtration). In 1892 Coley began his observations. The first plan was as follows: a bouillon culture was made of the streptococci; this culture was filtered through porcelain and an injection was given once a day into and about the sarcoma. The first dose was mx, and it was progressively increased. The effect was to cause a febrile reaction, and sometimes the injections lead to softening or suppuration. Coley's present method is as follows: make cultures of erysipelas cocci in cacao broth; there weeks inoculate them with the bacillus prodigiosus, and cultivate the mixed growth for four weeks. The mixed cultures are maintained at a temperature of 136° F. until they become sterile. This sterile fluid contains the toxins. The dose is from 1 to 8 minims. If the fluid is injected remote from the tumor the initial dose should be 1 minim. If the fluid is injected into the tumor the initial dose is 1 to 1 a minim (Wm. B. Coley, in "Am. Jour. Med. Sciences," March, 1906). The dose should be gradually increased until a chill occurs in from one-half an hour to two hours after the injection, followed by a temperature of 1010-104° F. In some cases there is so much depression after teaction that injections are given every other day, but if safely possible, they thould be given every day (Coley). The object is to obtain a reaction with each injection. The more vascular the tumor the more severe the reaction (Coley). If an area softens during treatment Coley advises us to open and drain the softened area. If improvement is going to occur it usually begins in from one to four weeks. If there is no improvement within four weeks there will not probably be any. It seems definitely proved that cases are occasionally cured by Coley's fluid. Spindle-celled sarcomata are influenced most favorably. Round-celled sarcomata are very refractory and so are cancers. The method is not entirely free from danger. It seems of value in post-operative cases to prevent recurrence. For this purpose it is used twice a week for several months and at greater intervals for a long period of time. Last autumn I brought before the class in the Jefferson Hospital a colored woman (Fig. 157) with an inoperable spindle-cell sarcoma of the thigh and groin. A portion of it was removed and the remainder completely disappeared from injections of Coley's fluid. She remains well at present over nine months after treatment was suspended. This patient had a violen reaction every day for weeks. She was given as much as 7 minims at a dose

Emmerich and Scholl claim good results in inoperable sarcoma from the injection of erysipelas serum. A sheep is injected with cultures of erysipelas the blood is drawn, the serum separated, filtered to remove cocci, and injected about the sarcoma. Results are not definite. Among other agents which have been used to inject inoperable sarcomata we may mention alcohol chlorid of zinc, arsenic, corrosive sublimate, thiosinamin, pepsin, alkalies, etc. The injection of anilin products into the sarcoma, which once received qualified commendation from some observers, has been abandoned by most



Fig. 157.—Huge sarcoma of buttock cured by partial extirpation and Coley's fluid.

surgeons. The x-rays are sometimes of benefit, but are not so serviceable as in carcinoma and possess a certain danger, for occasionally after using them dissemination rapidly occurs. Abbe and others have obtained some remarkable results with radium, but such results are the exception, not the rule.

Hypernephromata, or Adrenal Tumors.—Some of these tumors bear a strong resemblance to adenomata and carcinomata. Some adrenal tumors are benign, and among such tumors we note fatty and fibrous growths and growths resembling glioma. Another benign growth imitates the structure of the cortex of the adrenal. Malignant tumors occur, and many of them are identical or almost identical with sarcoma. One form is composed of epithelioid cells and resembles endothelioma. An adrenal tumor may arise from the adrenal body proper or from "rests" in ectopic portions of adrenal within the kidney, ovary, testicle, solar plexus, renal plexus, liver, mesentery, or some other part. Some of these tumors attain a large size. Metastases are late but tend to occur eventually even in hypernephromata which seem benign and may occur even when the primary growth has given rise to no symptoms. The metastases are lodged particularly in the bones, the lungs, and the liver In a case from which I removed a goiter and death resulted from reactionary.

hemorrhage, the tumor (which I had considered to be adenoma) was found to be composed of adrenal tissue. Unfortunately an autopsy was not permitted.

Accessory adrenals are common. They are known as adrenal rests. "They are found oftenest in the connective tissue about the main adrenals, but also in the kidneys, the right lobe of the liver, along the renal vessels and spermatic veins, in the inguinal canals, and in the broad ligaments" ("American Text-Book of Pathology"). Tumors may take origin from adrenal rests.

Innocent Epithelial Tumors.—These growths imitate an epithelial tissue of the mature and healthy organism.



Fig. 158.—Keen's case of papilloma with angioma.

Papillomata, or Warts (Fig. 158).—Papillomata are formed upon the type of cutaneous and mucous papillæ. A papilloma consists of a fibrous stroma which contains blood-vessels and lymphatics and is covered with epithelium of the variety appertaining to the diseased part. Papillomata grow from the skin and from mucous membranes; they may be single or multiple; many may form in one region or various distant parts may be affected; they may be painless or may be ulcerated or bleeding; they vary in color from light pink to deep brown or black. Papillomata of the skin are usually hard; papillomata of mucous membranes are soft. A skin-wart may be smooth and rounded, or may look like a cauliflower, the epidermis upon it being very

rough. A papilloma of a mucous membrane looks like a cauliflower. Papil lomatous masses may gather around the anus, the vagina, or the penis during the existence of a filthy discharge (venereal warts, Fig. 159), and crops of wart may appear on the hands of those who work in irritant material (as petroleum) Papillomata are apt to arise in mucous membranes about carcinomata of chronic ulcerations. A large crop of warts may disappear in a single night hence the popular belief in the efficacy of charms. Warts are particularly common on the skin of the back of the hands and fingers, the skin of the back and the skin of the neck and scalp. A single skin-wart may reach the size of a walnut and become pigmented. The squamous epithelium covering a skin-wart may become horny (a wart-horn). Other cutaneous horns arise from the nails, from the scars of burns, or from ruptured sebaceous cysts.

Villous papillomata grow chiefly from the bladder, but they may also grow from the stomach and intestine. A papilloma of mucous membrane covered



Fig. 159.-Venereal warts.

with squamous epithelium looks like a wart of the skin. Papillomata of the larynx are formed of squamous epithelium. Villous papillomata form tufte like the villous processes of the chorion; they may be single or multiple, and may be sessile or pedunculated; they are very vascular, and are apt to bleed freely. Papillomata may arise in cysts of the paroöphoron, in cysts of the mammary gland, from the choroid plexuses of the ventricles of the brain and from the spinal membranes. Papillomata may give rise to hemorrhag or may impair the function of a part. Any papilloma may become a cancer

Treatment.—Venereal warts are treated by repeatedly washing with peroxid of hydrogen, drying with cotton, and dusting with a powder compose of borated talcum or of equal parts of calomel and subnitrate of bismuth, of oxid of zinc and iodoform. If they do not soon dry up, cut them off wit scissors and burn with the Paquelin cautery. Ordinary warts may usuall be destroyed in a short time by daily applications of lactic or chromic acid. In multiple warts of the face Kaposi applies daily for several days a portion

of the following combination: sublimed sulphur, 3v; glycerin, 3iss; acetic acid, 3iiss. Keeping a wart constantly moist with castor oil will usually cause it to drop off. Warts, and even extensive callosities, may be removed by painting once a day for five days with pure carbolic acid and covering with lint kept wet with boric acid. A convenient plan is to paint a wart daily with a solution containing 1 part of corrosive sublimate to 30 parts of collodion (hydrarg. chlor. corros., 3ss; collodion, 3xv). Large warts should be exised. Villous papillomata of the bladder demand the performance of a suprapublic cystotomy in order to remove them. A papilloma of the larynx may be removed with the cautery loop or may be destroyed with the cautery.

Adenomata.—Adenomata are tumors corresponding in structure to normal epithelial glands. They have a framework of vascular connective tissue, and they may contain acini and ducts like racemose glands or tubes like tubular glands. The acini or tubules contain epithelium of either the ylindrical or polyhedral variety. Adenomata grow from secreting glands, but cannot produce the secretion of the glands from which they spring; or, they do secrete, the fluid is retained, and not discharged by the gland-ducts. Adenomata occur in the mammary gland, the parotid, the ovary, the thyroid gland, the liver, the sweat-glands, the sebaceous glands, the kidney, the pylorus, and the prostate; and they may spring as pedunculated growths from the mucous lining of the intestine and uterus. They are encapsuled, are usually single, but may be multiple, are of slow growth, but may attain a great size; they do not tend to recur after thorough removal, do not involve adjacent glands, and do not disseminate; they are firm to the touch; they lend to become cystic (especially in the thyroid gland), the fluid which distends the ducts being formed by mucoid liquefaction of the proliferating epithelium. If cysts form, the growth is spoken of as a cystic adenoma. If the framework of an adenoma contains considerable fibrous tissue, the tumor is named a fibro-adenoma. Adenomata are particularly liable to become carcinomatous.

In the breast a fibro-adenoma has a distinct capsule; it is elastic and movable, is usually superficial, and one occasionally exists in each gland. They are most common before the age of thirty, and are often painful, especially during menstruation. Cystic adenomata of the breast attain a large time; they are encapsuled and grow slowly, are most common after the thirtieth year, and are rarely painful. Both fibro-adenoma and cystic adenoma may arise in the male breast. Young unmarried women not unusually develop in the breast small, very tender, and painful bodies, most usually around the edge of the areola, which bodies increase in size and become more tender during menstruation; they are only cysts of the mammary tissue.

Adenomata of the thyroid gland usually begin before the fifteenth year.

Adenomata may arise in the prostate if that gland be already the seat of senile
hypertrophy. Adenomata of mucous glands may arise in the young or

middle-aged. Adenomata of mucous membranes often cause hemorrhage

and interfere with function.

Treatment.—Adenomata should be extirpated. To let them alone appears the patient to the danger of cancerous change. By confusing adenomata of the mammary gland with small cysts of that structure an erroneous belief has arisen that the former, as well as the latter, may sometimes be

cured by the local use of iodin, mercury, ichthyol, and the internal use of iodid of potassium. The treatment in the breast, as elsewhere, is excision.

Malignant Epithelial Tumors, Carcinomata, or Cancers .-Cancers are tumors taking origin from epithelial structures and composed of embryonic epithelial cells which are clustered in spaces, nests, or alveoli of fibrous tissue, and which proliferate enormously, extending beyond normal anatomical boundaries and as an invading host entering into connective tissue by way of the lymph-spaces. This unrestrained and unlimited reproduction of epithelial cells is the characteristic of cancer. The healthy epithelium has a strictly limited power of reproduction, as is illustrated by a skin-graft. Cancerous epithelium has an unlimited power of reproduction. The alveoli of cancer are distended lymph-spaces filled with proliferating cells. The cells of a cluster are not separated by any stroma, and the walls of the alveoli carry blood-vessels and lymphatics. The growth may be cancerous from the start, or may have begun, many think, as an innocent epithelial tumor. Cancers are always derived from epithelium (of glands, of skin, of mucous membrane, etc.), and if found in a non-epithelial tissue must be secondary. or must have arisen from a depot of embryonal epithelial cells of prenatal origin or from a dermoid cyst lying in the midst of a non-epithelial tissue, or epithelial cells must have been displaced so as to be among mesoblastic elements, by inflammation or injury. For instance, the bone does not normally contain epithelial cells. If osteomyelitis arises operation is performed and a lot of skin may be buried in the bone cavity or an epithelial graft may adhere. Such an epithelial area may become cancerous. Carcinomata have no capsules, rapidly infiltrate surrounding tissues, and are firmly anchored and immovable. In the beginning a cancer is a local lesion; but it soon attacks adjacent tissue



Fig. 160.—Secondary carcinoma of the submental and submaxillary lymphatic glands following carcinoma of the lip (Senn).

and related lymph-glands and by means of the lymph is carried to other structures, producing secondary tumors and diseases and enlargement of more distant lymph-glands. Finally lymph containing cancer-cells reaches the blood by the lymph-vessels and reaches distant parts and secondary tumors or metastatic deposits form. When lymphatic vessels are obstructed, lymph filled with cancer-cells may flow in a direction the reverse of that pursued in health. Widespread or general dissemination is due to carcinomatous thrombosis of a vein, or perforation of the wall of a vein, multiple emboli forming. Strange to say, emboli composed of cancer-cells may be surrounded with blood-corpuscles and move against the blood-current. A secondary growth (Fig. 160) consists of cells identical in

character with and similar in arrangement to those of the parent growth. The cells of the secondary growth were transported from the primary growth and

multiply in their new situation. For instance, the cells of a primary carcinoma of the liver may secrete bile, and the cells of a metatastic area may do the same. Futterer has reported a case of carcinoma of the thyroid the pulmonary metastases of which secreted colloid. Stewart reported a case of cancer of the lungs and liver secondary to cancer of the pancreas. The secondary growths were of a structure similar to the pancreas and contained trypsin. Metastases from a columnar-celled rectal cancer are composed of columnar cells. Metastases from a squamous-celled epithelioma are composed of squamous cells. In rare cases metastasis of carcinoma of the stomach has occurred in the rectum. Schnitzler reported 11 such cases ("Mitth. a. d. Grenzgeb. der Med. u. Chir.," 1908, xix., No. 2). Such a condition is probably due to implantation. Contact cancer has already been referred to (page 344). We often speak of lymph-nodes enlarging when affected with cancer. The enlargement certainly occurs, but is not due to growth of the cells of the lymph-node. It results from multiplication of the carcinoma cells deposited in the gland. As Henry Morris says ("The Bradshaw Lecture," "Lancet," Dec. 12, 1903), the parenchyma of the involved part does not undergo transition into cancer. After the growth of epithelium has lasted for a length of time the patient becomes poisoned by materials absorbed from the seat of disease, and finally dies from cachexia and exhaustion or some complication. Cancer is rare before the age of forty, although occasionally it is met with in younger persons. Cancer of the rectum is sometimes met with as early as the twenty-fourth year. I have operated on a woman of twenty-six for cancer of the breast and on a man of twenty for epithelioma arising in the old scar of a burn (Fig. 82). When xeroderma pigmentosum exists in children, cancer may arise in areas of the distase. If cancer appears in a young person, growth is sure to be extremely rapid. A carcinoma is often the seat of pricking pain; the growth tends strongly to recur after removal; is prone to ulcerate, causing pain, hemorrhage, and cachexia; makes rapid progress, and is often fatal in from one to two and a half years. It is more common in women than in men, and rarely exists in association with tubercle. After a cancer has existed for a time in an important structure, or after a superficial cancer has ulcerated and become hemorrhagic, there are noted in the individual evidences of illness and exhaustion. We speak of this condition as the cancerous cachexia, and in it the muxles are wasted, the body-weight is constantly diminishing, the complexion is sallow, the face is sunken, pearly white conjunctivæ contrast strongly with the yellow skin, the pulse is weak and rapid, and night-sweats occur. The above condition is due to the absorption of toxic products from the diseased tissues, which products damage the blood-corpuscles, and also to pain, loss of sleep, deprivation of exercise, malassimilation of food, and perhaps bleeding. Mental depression is not believed by many surgeons a cause of recurrence. As J. D. Bryant says, it is simply expressive of a condition of nutritive failure which may favor recurrence. We must remember, however, that the great name of Paget is associated with the belief that not uncommon antecedents of the disease are "deep anxiety, deferred hope, or disappointment" ("Lectures on Surgical Pathology," 1863). Recurrence after operation is due to the growth of cells which were not removed at the operation. Cancer may kill by obstructing a canal, by destroying the functions of a viscus organ, by hemorrhage, by anemia, by sepsis, or by exhaustion.

Serum Reaction in Cancer.—Kelling, in 1906, pointed out that the bloodserum of a cancer patient has a hemolytic action on the red corpuscles of the lower animals. It has been known for some time that the serum of persons affected with certain diseases is able to destroy the red blood-corpuscles of normal individuals; in other words, such sera are hemolytic to the red bloodcorpuscles of healthy human beings. The agents in a serum which hemolize the red corpuscles in other sera are called isohemolysins. Isohemolysins are contained in the sera of syphilis, tuberculosis, and cancer. Weil pointed out that the serum of a dog suffering from advanced lymphosarcoma destroys the red corpuscles of normal dogs, but is resisted by the red corpuscles of animals that are victims of the same disease. Attempts are being made to utilize the serum reaction for diagnostic purposes. Different observers employ different technic and differ widely in their conclusions. Crile ("Jour. Am. Med. Assoc.," Dec. 12, 1908) is disposed to think highly of the diagnostic value of the serum reaction. Janeway ("Annals of Surgery," May, 1909) obtained positive results in 48.5 per cent. of the 35 cancer cases examined. Janeway's conclusions are wisely cautious. He states that a negative reaction is not proof positive that cancer is absent. A positive reaction makes the existence of malignant disease probable, especially if advanced tuberculosis and syphilis are absent.

The fact that the serum of a cancer patient contains agents destructive to red corpuscles explains the anemia and cachexia of cancer. Janeway points out that the serum of sufferers from benign tumors never exhibits the reaction.

Cause of Carcinoma.—Heredity is discussed on page 342.

1. Irritation.—As Dennis says, clinical evidence points strongly to the view that inflammatory changes following irritation are responsible for cancer. Individuals with phimosis are particularly prone to cancer of the penis. Those who smoke a short-stemmed clay pipe, which grows hot when in use, are most liable to cancer of the lower lip. In the old days chimney-sweeps often developed cancer of the scrotum, which was always irritated by soot in the cutaneous folds. Cancer of the gall-bladder may arise if gall-stones exist. Cancer of the skin of the hands may arise in x-ray workers. Cancer of the skin may be induced by the influence of light (James Nevins Hyde, in "Am. Jour. Med. Sciences," Jan., 1906). An ulcer may be the irritating focus which leads to the development of cancer at its edge (see Marjolin's ulcer, page 175). So may a scar. As is well known, certain innocent tumors may become cancerous. The believers in the parasitic theory maintain that irritation and inflammation simply open the gates to the real cause, which they assert is a parasite.

In certain regions of the body, notably the tongue and lip, we regard prolonged chronic inflammation as very apt to eventuate in cancer, and if it is not cured by ordinary means we advise operation. A condition persisting in spite of ordinary treatment, prone to eventuate in cancer, but not as yet demonstrably cancerous, is called the *pre-cancerous* stage of cancer. It probably is already cancer, although so early as to lack the positive signs.

A wart is the result of an inflammation and a wart may become a cancer. The edge of a gastric ulcer may become cancerous. Cancer may arise from a scar or the edge of an old ulcer of the skin, the lip, the cheek, or the tongue.

Certain benign tumors tend to become cancerous, especially if irritated by injuries, caustic applications, or inefficient attempts to remove them surgically. Any papilloma and any adenoma may become cancerous. A benign epithelial tumor is always a menace and is to be regarded as a possible or potential carcinoma.

Whereas chronic inflammation or irritation of epithelial structures is not infrequently followed by carcinoma, a single traumatism, as a blow, very seldom is. A woman with cancer of the breast is apt to lay the blame upon a blow, but very seldom can the surgeon regard the blow as causal. In many cases cancer was present when the injury was received, and the injury drew attention to the tumor. Tissues degenerated by advancing age are particularly prone to develop cancer from irritation. In De la Camp's collection of 9006 cases, only

19 were under twenty years of age. Victims of rheumatoid arthritis seem particularly liable to cancer.

Cancer is most common beyond the age of forty, and the liability increases as years increase. Although old people are most liable to cancer, the growth is not nearly so malignant in them as when it occurs in young persons.

2. The Inclusion Theory of Cohnheim.—This theory was set forth on page 341.

3. The Thiersch Hypotheris.—This maintains that normal, healthy connective tissue has a restraining influence on the growth of adjacent epithelium; when connective tissue degenerates (as in advancing years or after prolonged irritation) its control over epithelium is weakened



vancing years or after prolonged irritation) its control patient two years prior to admission.

and the epithelium grows more rapidly than it does normally, and from the moment it invades the connective tissue cancer exists. This theory assumes that the connective tissue is a police force and the epithelial cells the criminal class. When the first is weakened or corrupted the second becomes active and uncontrolled.

 The Parasitic Theory.—Various agents have been described as causes, viz., bacteria, protozoa, and yeast fungi.

This theory was discussed on page 343. We do not regard it as proved, and even Plimmer, warm advocate as he is of the theory of contagion, admits that as yet there is no clearly demonstrated case of the transference of cancer from one man to another. I can find no authenticated case on record of a surgeon having been infected by cancer during an operation. Transplantation has been carried out from one animal to another of the same species, although attempts to do so usually fail. Tyzzer, of Harvard, succeeded in

nearly at per cent. of his inoculation experiments with the Jensen tumor and he has kept up the tumor formation for ten generations. (See Fourth Reportions the Harvard Medical School of the Caroline Brewer Cruit Fund Cancel Commission.) It is a serious question, however, if mouse cancer is really cancer at all. Mouse cancer is far more strongly hereditary than human cancer; spontaneous cure is by no means uncommun; metastasis is rare; the disease may occur as an epidemic in a laboratory. It has been asserted that it may revert to surcoma (Apolant, in "Münch med. Wochenschr.," 1907, liv.), and it may revert to adenoma (Apolant, Ihid.). These tendencies separate mouse cancer very positively from human cancer. It has not been transplanted from an animal of one species to an animal of another species. In any case even a successful transplantation of cells is a very different thing



Fig. 162.—Carrinomatous horn.

from contagion. The late Prof. Nicholas Senn deliberately implanted a piece of cancer in the tissues of his own forearm without result ("Jour. Am. Med. Assoc.," April 28, 1906). Recently advocates of the contagion theory claim that mouse cancer can be reproduced after transplantation even when the cells in the inoculated matter have been killed by exposure to the intense cold induced by liquid air (Salim, Moore, and Walker, in "Lancet," Jan. 25, 1908). If these observations should be sustained, they

would indicate that the element responsible for growth of a graft is not cellular and might be microbic. Alibert carried out similar experiments with like results.

5. The Biological Theory.—In a unicellular organism the function of reproduction is, of course, possessed by the cell. In a multicellular organism certain cells are set apart for the performance of the function of reproduction, but all the cells possess the potentiality for reproduction, but fail to exercise it. If cells undergo atavistic reversion they may again assume the reproductive function. If they do, unrestrained growth will result, and such unrestrained growth is cancer.

N. F. MacHardy ("Lancet," Oct. 24, 1903) states that if a unicellular organism has not sufficient reproductive energy it fuses with another cell and is thus stimulated to produce numerous daughter-cells. In multicellular organisms cells may also fuse, take on active reproductive power, and produce hosts of new cells. When cells are persistently irritated, MacHardy affirms that they become worn out by making repeated attempts at repair, undergo atavistic reversion, and actively assume the power of reproduction. According to this theory cancer is expressive of atavistic reversion of epithelial cells.

The Prevalence and the Alleged Increase of Carcinoma.—Crile estimates that at the present time there are probably 80,000 cases of cancer in the United States, and states that in hospital autopsies cancer is found

in 1 case out of 12 ("Med. Record," June 6, 1908). Is cancer increasing? Of course the number of cases increases with the increase of population. The apparent death-rate from cancer increases year by year. It is pointed out by W. Roger Williams that in England and Wales the mortality from cancer has increased from 1 to 5646 in 1840, to 1 to 1306 in 1896, and the proportion lodeaths from other causes has risen from 1 to 120 in 1840, to 1 to 22 in 1806.\* Roswell Park comments on the increasing number of deaths from cancer in New York State, and says if it continues for the next ten years the disease will kill more persons annually than phthisis, smallpox, and typhoid combined. It has been stated that of persons living above the age of thirty-five, that I woman in 8, and I man in 12, will die of cancer (Copeman, quoted by Brand, in "Lancet," Jan. 11, 1908). Such statements are truly alarming, and yet the reality of all of this apparent increase is doubtful. A part of the apparent increase is due to the greater frequency of exploratory operations for diagnostic purposes, to the greater frequency of post-mortem examinations, to more correct diagnoses of obscure internal conditions, and to greater accuracy than was once either usual or expected in filling up death certificates. Neusholme says that just as deaths certified as due to old age grow apparently fewer every year, so other non-specific certifications grow fewer, and cancer gains as they lose. The diminution in infant mortality also causes a relative rise in the apparent cancer mortality. The above facts certainly account for a portion of the alleged increase, but we must also remember that we are curing many more cases by operation than we used to be able to, and hence that the death-rate from cancer is not the real and final measure of the incidence of cancer. The experience of most practical surgeons is that there is a real increase in cancer, but the extent of the increase cannot be ascertained with any accuracy.

Hereditary Influence.—This was referred to on page 342. It can be at most only tissue predisposition or a diminution of tissue resistance to the real cause of cancer, whatever that may be. Some previously quoted cases are too impressive to be regarded as coincidences. Williams ("Brit. Med. Jour.," May 9, 1908) points out that 24.2 per cent. of women with cancer of the breast have or had relatives with a history of cancer. Williams states that Butlin's estimate is 37 per cent.; Leaf's, 23 per cent.; and Nunn's, 29.3 per cent.

Immunity.—This was referred to on page 342.

It is known that mouse tumors which follow transplantation in some cases retrogress and undergo spontaneous cure, and that animals in which this has occurred are found to have become immune to a reinoculation of a like tumor. Crile and Beebe present some studies on this interesting subject in the "Journal of Medical Research," June, 1908. Gaylord and Clowes found that the serum of an animal thus rendered immune tends to destroy tumor cells, and experimented with the transfusion of the blood of immune animals into animals with active tumors; 7 animals out of 10 were cured. The blood of an animal naturally immune to tumor inoculation is said to act similarly to that of an animal which has acquired immunity, as shown by retrogression of a tumor.

Distribution of Cancer.—It occurs in all climates, and all races except

Eskimo are liable to it. It is more common, however, among the civilized

\*"Lancet," Aug. 20, 1898.

than the barbarous. It is rarer among the black and yellow races than the white race. The American Indian seldom suffers from it. It occurs in the lower animals far less often than in man, is more common in domestic than in wild animals, and in captive wild animals than in those free and at large. It can even occur in cold-blooded animals. Cancer is most common in the temperate zone. It is usually asserted that the disease is rare in the tropics, but Dudley denies that this statement is true of the Philippine Islands ("Jour. Am. Med. Assoc.," May 23, 1908). Cancer is certainly less common in India than in England, and it is very rare in Greenland. It is almost unknown among the natives of Algeria. It is usually believed that cancer is most prevalent in low and marshy districts. It is less common at high altitudes and among the dwellers on soils of chalk and lime.

Cancer Regions and "Cancer Houses."—Some regions show a remarkable frequency of cancer. In Bookfield, New York, during five years nearly

10 per cent. of the deaths were due to cancer.

Tynes ("Jour. Am. Med. Assoc.," March 21, 1908) reports that in Fisherville, Pennsylvania, in 265 families there were 105 deaths, and 18 of them were due to cancer. It is maintained by Haviland and others that certain houses become infected and that cancer appears in such houses again and again among successive families inhabiting them. Such houses are called "cancer houses," and many remarkable facts have been collected relating to them, facts which to some observers seem to prove contagion, but which to others merely serve as interesting examples of coincidence.

Leeson ("Practitioner," Feb., 1909) is of the latter opinion and shows that there was not a cancer house in his district. He studied 248 cases of cancer and all but 4 of them were in different houses. As this author says: "If we are to accept such evidence as that on which the belief in cancer houses is founded, we must believe in 'apoplexy houses,' 'liver houses,' etc."

Influence of Diet.—Some blame meat, some tomatoes, etc., for the development of cancer. Vernueil and Reclus, commenting on the fact that carnivora are much more prone to cancer than herbivora, suggested that the increase of cancer during recent years might be due to the increased consumption of meat by the poorer classes. There is no proof of the truth of this suggestion. In fact, Prof. Senn points out that the Eskimos seem immune to

tumor formation, yet they live on an exclusive animal diet and, furthermore, are the healthiest people in the world.

Recurrence After Operative Removal.—This is usually due to the fact that all of the cells were not removed. Such recurrence may be due to cutting across lymph tracts and flooding the wound with carcinoma cells, which lodge and grow. The growth of cancerous nodules in the abdominal scar resulting from an exploratory operation for cancer of the stomach is observed every now and then. It is probably due to contact invasion of the scar area, which area has lessened vital resistance to cancer cells.

Murphy thinks that the same explanation holds when the stitch cicatrices become cancerous ("General Surgery," by John B. Murphy, in "Practical

Medicine Series for 1909").

Extension of Cancer.—It spreads by the lymphatics and rapidly involves the anatomically associated lymph-nodes. In the nodes the migrating cancer cells are imprisoned for a time, and in this incarceration lies the hope of surgery. The adjacent glands are involved much more rapidly than we used to think. They are usually involved within a few weeks of the start of the growth, except in superficial epithelioma, in which cases they are not involved at all.

In a structure devoid of capsule (as the tongue, the mammary gland, etc.), Lockwood points out that involvement of related lymph-nodes is practically immediate.

Lymphatic involvement may result in the formation of a mass much larger than the parent growth. The ducts between the primary cancer and the involved glands are filled with carcinoma cells and their walls become infiltrated. Hence in an operation the ducts should not be cut across or the wound will be flooded with fluid rich in cancer cells and the ducts should be extirpated as well as the glands. To flood the wound with fluid containing embryonic cells is very dangerous, for some of them may adhere, multiply, and reproduce the disease. After a time the capsules of cancerous nodes rupture and periglandular tissue becomes involved. The cells are held in the first glandular stopping place (the anatomically related glands) for a time, but sooner or later other and more distant glands become involved. In certain abdominal cancers (stomach, rectum, and uterus) the thoracic duct may become obstructed by cancer cells. Large glands may cause much trouble from pressure. When they soften and break down the skin becomes involved and dreadful sores form, oozing foul matter and blood. Death may be due to hemorrhage from a large vessel which has become infiltrated.

Several times I have been consulted by patients on account of glandular enlargements of the neck, the patients never having noticed a small primary lesion in the mouth, and yet the entire glandular disease was secondary to the limited oral trouble.

Dissemination or Metastasis.—These terms mean the formation of secondary growths. These growths are formed by small fragments of cancer being broken off and carried to lodgement in distant structures. Such small fragments are called cancer emboli. Cancer emboli may be carried by lymph or blood. When cancer emboli lodge in a region favorable to their growth their constituent cells multiply and produce secondary growths. A secondary growth is the histological counterpart of the parent growth, and an examination of a secondary growth gives us accurate information as to the nature of the primary growth. In cancer of the rectum there may be secondary deposits in the liver or in bone containing structure-like rectal glands. In cancer of the stomach secondary nodules in the skin may contain structure resembling the gastric glands. Secondary deposits are by no means as common in cases of squamous-celled cancer as in glandular cancer.

Another method of dissemination is observed in the abdomen. When cancer of a viscus breaks through the peritoneal coat, the cells are spread widely by peristaltic movements and peritoneal fluid, and the peritoneum becomes extensively involved. This involvement is a form of contact cancer. Any structure may be the seat of a secondary growth. The lung is frequently affected, so is the liver, so are the bones. Any organ or tissue may become the host for secondary deposits of carcinoma.

Spontaneous Disappearance of Cancer.—This is an excessively rare event in human beings, but it does occasionally occur. Gaylord has collected 11 cases which he considers authentic, viz., 2 epitheliomata (1 of the tongue and

1 of the lip), 1 scirrhous cancer of the breast, 1 malignant adenoma of the rectum, and 7 cases of chorion carcinoma ("Seventh Annual Report of the Cancer Laboratory of New York State Department of Health"). The same author also notes the spontaneous disappearance of two sarcomata. Spontaneous disappearance of Jensen tumors successfully inoculated in mice is quite common. It occurred in 23 per cent. of Gaylord's animals. Spontaneous disappearance is not due to the fatty degeneration and necrosis so often found about the center of a carcinoma, but to deprivation of the epithelial cell



Fig. 163.—Carcinoma of the auricle.

of some or all of its vitality by an utterly unknown process. Some observers think spontaneous cure is brought about by the stimulation of an immunizing force. When spontaneous cure occurs cancer cells are gradually replaced by scar tissue, and the resulting scar may contain cancer cells immeshed in it. Hence, after apparent retrogression, growth may begin anew.

Besides the apparently positively authenticated cases reported by Gaylord, there are numerous cases on record in

which it is highly probable cancer disappeared spontaneously. These cases are collected in the appendix to the previously cited report of Gaylord.

Blood Changes in Cancer Cases.—In early cases there is no notable change in either erythrocytes or hemoglobin. In more advanced cases as cachexia begins a secondary anemia develops, fall of hemoglobin antedating diminution in leukocytes.

The anemia may become so profound that it resembles pernicious anemia; in fact, some observers have asserted that pernicious anemia may arise. The anemia of cancer is not benefited by medical treatment.

In gastric cancer, because of vomiting and diarrhea, blood concentration may occur, the red corpuscles being 6,000,000 or even 7,000,000 per cmm.

The leukocytes may be normal, but are often increased. It has recently been claimed by Macalister and Ross ("The Lancet," Jan. 16, 1909) that the blood of a patient with cancer contains a material in its plasma which is an excitant for the leukocytes of healthy persons. As previously stated (page 380) the serum of the blood of a person with cancer contains agents destructive to the red corpuscles of healthy blood.

Classification of Carcinomata.—Carcinomata are classified as follows:

(1) Epithelioma; (2) rodent ulcer, or Jacob's ulcer; (3) spheroidal-celled cancer; (a) schirrous; (b) encephaloid; (c) colloid; and (4) cylindrical-celled cancer. Clinically we speak of cuirass cancer, a condition sometimes arising when the mammary gland is cancerous and due to the infiltration of the cutaneous lymphatics with cancer-cells; chimney-sweeps' cancer and paraffin workers' cancer, if either of these occupations seems to have been causative;

cancer à deux, a phrase used in France to signify that carcinoma has occurred in two persons of a household who are not blood relations, but have been in close contact; contact cancer, when cancer appears in an area which was in close contact with a cancerous area in the same individual—for instance, when a cancer of the upper lip follows a malignant growth of the lower lip; when a carcinoma of the face follows a like growth of the hand; when a cancer appears on the penis of a husband whose wife has cancer of cervix uteri or ragina. A melanotic carcinoma is a form of encephaloid in which the cells contain melanin. Scirrhous cancer contains much fibrous tissue and is densely hard. An encephaloid is very soft or brain-like. Marjolin's ulcer is an epithelioma which arises from the epithelial edge of a chronic ulcer, a scar or a sinus (page 175). Fig. 82 shows a Marjolin ulcer arising in the scar of a burn.

Epitheliomata.—An epithelioma arises from surface epithelium, and may arise from squamous cells or cylindrical cells, according to the location.

Squamous-celled epithelioma (Fig. 161) takes origin from the skin or from a mucous membrane covered with pavement epithelium. It is especially apt to appear at the junctions of skin and mucous membrane (as the lips) or the point of juxtaposition of different kinds of epithelium. Such a growth may arise in the anus or vagina; on the penis, scrotum, lips or tongue; in the mouth or nose; on the skin, and other situations. There is an ingrowth of surface epithelium into the subepithelial connective tissue, colonies of cells growing inward and forming epithelial nests. It may arise without discoverable cause, it may follow prolonged irritation, or it may arise in a wart or fissure. In the nipple it is not very unusually, and in the scrotum and nose it is occasionally, preceded by a persistent dermatitis due possibly to psorosperms, and known as Paget's disease. Paget's disease is not true eczema, but is rather malignant dermatitis. A crust gathers on the part, and beneath this crust is a raw, red, and moist surface, the edge of which is slightly elevated and somewhat indurated. In the beginning there is a strong resemblance to eczema. The nipple is apt to retract. The parts are the seat of a constant itching and scalding sensation. The area may become cancerous in a few weeks, but may not for years. I have recently seen a case of Paget's disease of the glans penis. Squamous epithelioma generally begins as a warty protuberance which soon ulcerates. A malignant or true cancerous ulcer (Fig. 161) has a hard, irregular base, uneven edges, a foul, fungus-like bottom, and gives off a sanious or ichorous discharge. This ulcer is the seat of sharp, pricking pain, sometimes bleeds, and extends over a considerable area, embracing and destroying every structure. Epithelioma usually affects lymphatic glands early, but such infection may be delayed for eight or ten months. Epitheliomatous glands break down in ulceration, making frightful gaps and often causing fatal hemorrhage. Dissemination is not nearly so common as in other forms of cancer, but it does sometimes

Cylindrical-celled Epithelioma.—This form of growth takes origin from structures covered with or containing cylindrical epithelium, and it contains cylindrical or columnar cells. It is composed of a stroma of fibers between which lie tubular glands lined with columnar epithelium and containing masses of epithelial cells. Such tumors are found in the uterus and gastro-

intestinal tract, and may begin from the surface epithelium or from the cells of tubular glands. In these tumors there is an acinus-like structure and the spaces are filled with proliferating epithelium. Cylindrical-celled cancers also arise from the mammary gland, liver, and kidney. One of the most common seats of cylindrical cancer is the rectum. Cancer of the rectum may occur at an earlier age than cancer elsewhere, being not uncommon between the ages of twenty-eight and forty. Cylindrical-celled epitheliomata are at first covered with mucous membrane, but they soon ulcerate and involve the submucous and muscular coats in the growth. They grow rather slowly, usually, but not always, cause lymphatic involvement, and finally discenti-



Fig. 164.—Rodent ulcer. Case in the author's wards in Philadelphia Hospital.

nate widely. They require in some regions from five to years to cause death. In rectum, however, growth is mumore rapid and few victims cylindrical-celled carcinoma the rectum, if unoperated upon live beyond 2 years and many them die long before this period.

A rodent or Jacob's ulcer, epithelioma exedens or cancroid (Fig. 164), was called by the older surgeons "noli me tangere," because they found that surgical interference (incomplete removal as we now know) was sometimes followed by very active growth. A rodent ulcer is scarcely ever met with except upon the face though Jonathan Hutchinson saw one upon the forearm, and James Berry met with one upon the

arm. It is especially common upon the nose and forehead. It begins after the age of forty as a little warty prominence which ulcerates in the center, the ulceration progressing at a rate equal to the new growth. The ulcer becomes deep; it is not crusted; its edges are irregular, hard, and everted; the floor is smooth and of a grayish color; the discharge is thin and acrid; and the parts about the sore contain numbers of visible vessels. Jacob's ulcer grows slowly, may last for years, does not involve the lymphatics, produces no constitutional cachexia, and is rarely fatal. In some cases, although growth is very slow, destruction eventually becomes very great because of ulceration, there is great loss of tissue and horrible deformity. A rodent ulcer is usually considered to be a malignant epithelial growth which springs from a sweat-gland, a sebaceous gland, or a hair-follicle, but Kanthack asserts that before ulceration the rete and the sweat-glands are normal, but the sebaceous glands are destroyed. The base and edges of the ulcer are hard, which differentiates it from lupus; and, further, the bacilli of tubercle may sometimes be cultivated from the discharge of an area of lupus (page 250). Rodent ulcer begins below the skin, ordinary epithelioma begins in the skin, and a rodent ulcer contains no cell-nests. A rodent ulcer very rarely undergoes cicatrization, a fact which differentiates it from lupus. Occasionally, but very rarely, a small portion of the growth sloughs out and a temporary scar forms at this point.

Adenocarcinoma or Glandular Carcinoma.—Glandular carcinomata in structure resemble racemose glands. They consist of a stroma of connective tissue and alveoli filled with proliferating epithelial cells. If the proportion between the fibrous stroma and the cellular elements is about the same as in a normal gland, the growth is called simple. When the cellular element is in excess the growth is soft (medullary), and when the fibrous stroma is in excess the growth is hard (scirrhous).

I. Scirrhous carcinoma is a white and fibrous mass which has no capsule, which infiltrates tissues, and which draws in toward it, by the contraction of its outlying fibrous processes, adjacent soft parts, thus producing dimpling, or, as in the breast, retraction of the nipple. It is composed of spheroidal cells in alveoli formed of connective-tissue bands. The commonest seat of scirrhus is the female breast. It occurs also in the skin, vagina, rectum, prostate, uterus, stomach, and esophagus. It is most frequent in women after forty. It begins as a hard lump which is at first painless, but which after a time becomes the seat of an acute, localized, pricking pain. This lump grows and becomes irregular and adherent, causing puckering of the soft parts. After the skin or mucous membrane above it has become infiltrated ulceration takes place and a fungous mass protrudes which bleeds and suppurates. The adjacent lymphatic glands usually become cancerous, the time occupied being from six to ten weeks, and constitutional involvement is rapid and certain.

2. Medullary or encephaloid carcinoma is a soft gray or brain-like mass. It is a rare growth, it has no capsule, and it may appear in the kidney, liver, ovary, testicle, mammary gland, stomach, bladder, and maxillary antrum. An encephaloid cancer often contains cavities filled with blood, and this variety is known as a "hematoid" or a "telangiectatic" carcinoma. These growths are soft and semi-fluctuating, they infiltrate rapidly and soon fungate, and they terminate life in from a year to a year and a half. If the cells of encephaloid become filled with melanin, the condition is called "melanosis" or "melanotic cancer."

3. Colloid cancer is extremely rare. It arises from either a scirrhus or an encephaloid, when the cells or the stroma of such a growth undergo colloidal degeneration. On section there will be seen in the center of the growth a series of cavities filled with a material resembling honey or jelly; the periphery is frequently an ordinary scirrhus or encephaloid cancer. Colloid degeneration is most prone to attack carcinomata of the stomach, mammary gland, and intestine. The name colloid cancer is often given to glistening, gelatinous, malignant growths springing from the ovary, testicle, mammary gland, or gastro-intestinal tract. The condition is due to mucous degeneration of the connective tissue or of the epithelial tissue of a carcinoma. Only a portion of the tumor may degenerate or the entire mass may become gelatinous.

Syncytioma Malignum.—By this name is meant a malignant epithelial growth arising from the site of the placenta during pregnancy or the puerperal state. It resembles placenta in appearance and rapidly causes metastases by way of the blood-vessels. It is quickly fatal.

Treatment.—Cancer is so prevalent, is so dreadful in its nature and inexorable in its progress, tends so strongly to cause death in from two to five years, people are so afraid of it, and so many physicians are hopeless of curing it that multitudes seek relief from the obsessed Christian scientists or from the vulgar criminal quacks. It cannot be too strongly insisted that in the beginning cancer is a local disease curable by early and radical operation, that early diagnosis should be made, and that prompt operation is imperative. Delay is not only disastrous, it is usually fatal. Certainly at least 50 per cent. of the cases of cancer I see are beyond operation when they are first brought to the hospital, they having sacrificed the golden moments during which cure was possible. Carcinomata demand early and wide excision, with removal of implicated glands. Anatomically related lymph-nodes must be removed even if they show no evidence of involvement. If operation is early and thorough, and if certain regions are involved, a considerable proportion of cases can be cured. Carcinomata of the lip, the skin, and the mammary gland can often be cured. A recurrent growth may be removed as a palliative measure, to lessen pain and to relieve the patient from ulceration and hemorrhage, but such an operation is rarely curative. If a growth does not recur within five years after removal, a cure has probably been attained; in fact, if there is no recurrence within three years, the case is probably cured. The three-year limit has been usually accepted since Volkmann's paper on the subject. A rodent ulcer should be excised or else be curetted and cauterized with the hot iron or the Paquelin cautery. In cancer of the lower lip, remove the growth by Grant's operation (q. v.), or by a V-shaped incision, or cut away the entire lip. In every case remove the glands beneath the jaw. In cancer of the tongue, excise this organ and also the lymph-nodes from beneath the jaw and in the anterior carotid triangles. In cancer of the breast, remove the breast, the pectoral fascia, and the great pectoral muscle, and take away the fat and glands of the axilla. In cancer of the rectum, if near the surface, excise the rectum from below; if above five inches from the anus, do the sacral resection of Kraske and then remove the growth. In cancer of the esophagus, perform gastrostomy; in cancer of the pylorus, perform pylorectomy or gastro-enterostomy; in cancer of the bowel, do resection with end-to-end approximation, side-track the diseased area by an anastomosis, or make an artificial anus; in cancer of the penis, amputate and remove the glands of the groin. Erysipelas toxins and erysipelas serum have been tried in inoperable carcinoma, but without any positive benefit. Von Leyden and Blumenthal ("Deutsche medicinische Wochenschrift," Sept. 4, 1902) report benefit to human beings suffering from cancer by the injection of serum expressed from carcinomatous tumors. Such observations require many confirmatory studies before we can assume that a remedy has been found. Pyoktanin, thiosinamin, trypsin, and many other materials have come upon the scene like plausible confidence men, but each was soon exposed. There is no drug and no serum at present known to be capable of curing cancer. Honest investigators have at times been lead into error by forgetting that at times the rate of growth of a cancer may temporarily lessen or that growth may for a time actually cease. (See Lewis S. Pilcher's address before the Surgical Society of Brooklyn in Feb., 1909.) Fulguration (application of powerful sparks from a metal electrode) is advocated by Czerny, but the sparks produce

a local effect only and cannot reach involved lymph-nodes. The x-rays are of distinct value in certain cases of carcinoma. Surface growths may be apparently cured, although, unfortunately, they are apt to return even after total disappearance. Deeper growths are apparently not benefited. The knife is to be preferred to the x-rays, except in very superficial skin cancer about the erelid or nostril, and in inoperable cancer. The real curative power of adium is as yet undetermined. The x-rays and radium have a certain influence in lessening the pain of cancer. In some cases ligation of the artery of supply or extirpation of the artery, as suggested by Dawbarn, notably retards growth. I have been able to confirm this statement. In cancer of the breast, oophorectomy occasionally produces benefit or even cure (Beatson's operation). In inoperable cases palliative operations may be justifiable to relieve some urgent discomfort or get rid of a foul or bleeding mass. Gastroenterostomy, gastrostomy, and colostomy are palliative operations. In a malignant growth of the nasopharynx tracheotomy may be required, and in a malignant growth of the bladder it may be advisable to perform suprapubic costotomy. In an inoperable case relieve the pain by opium, giving as much as may be required to secure ease. Opium so used seems not only to relieve pain, but to retard the growth of the tumor and to favor the development of fibrous tissue in the stroma. Some surgeons have tried injecting serum from one of the lower animals suffering from the disease, but results are entirely incondusive. Others have given atoxyl. Erysipelas toxin is of slight value in cancer.

Malignant Growth from Congenital Pigmented Mole.—As previously stated, the embryonic origin of the pigment-producing cells is uncertain. Some regard a malignant growth of a congenital pigmented mole as epithelioma, others as alveolar pigmented sarcoma. It is probably carcinomatous.

Malignant change seldom occurs before the fiftieth year, the growth rarely attains a large size, metastasis takes place very rapidly by the blood and lymphatics, and the patient seldom lives more than a year after malignant change begins. (See Bloodgood, in "Progressive Medicine," Dec., 1907.)

Because of the danger of subsequent malignant change it is wise to remove large pigmented moles. Every pigmented mole which is irritated or begins to enlarge must be removed, and the associated lymph-nodes should also be removed. Bloodgood knows of no definite cure on record of a malignant tumor arising in a pigmented mole. Prevention is easily secured by extirpation before the onset of malignancy.

Cystomata.—A cystoma is a benign cystic tumor in which the cells of the cyst-wall constitute the new growth. The cyst contents are derived from the cells of the wall. The tumor is the cyst-wall; the cells of this wall are derived from the epiblast, the hypoblast, or the mesoblast, and are either epithelial or endothelial. The cells of the cyst-wall adhere to connective tissue which seems to constitute a part of the wall. A thick wall contains much connective tissue, a thin wall very little. The nature of the contents is dependent on the character of the cells which constitute the tumor. Cysts fined by endothelium contain serous fluid; a cyst of the thyroid gland usually contains colloid material; a cyst lined by flat epithelial cells contains matter resulting from fatty degeneration, etc.

Cystomata may be congenital or acquired, and an acquired cystoma may arise after injury or follow inflammation. The cyst may increase in size

progressively or its growth may be halted. The wall may become calcareous or even bony. When a cyst has one cavity, we call it monolocular; when there are several or many cavities, it is called multilocular.

Varieties of Cystomata.—The chief varieties are: Traumatic epithelial;

atheromatous; mucous; mesoblastic.

Traumatic Epithelial Cystomata.—These growths have been called traumatic dermoids. Such a growth may arise after an injury which carries and deposits epithelial cells or a bit of skin deep into the connective tissue. For instance, a punctured wound of the hand may be followed by an epithelial cystoma. It may arise after a scalp wound or in the scar of a burn. The cyst grows only to a certain size and then remains stationary. It is lined by pavement epithelium and it contains products of the fatty degeneration of epithelial cells.

Treatment.-Extirpation of the wall.

Atheromatous Cystomata.—These growths, according to Senn, are met with particularly in the ovaries, in the orbital region, and at the base of the tongue, but they can arise almost anywhere. They may remain small or may attain a great size. Such a cystoma contains epithelial cells which have undergone fatty degeneration and sometimes contains oil. An atheromatous cystoma is deep seated and is not connected with the skin, in contrast to a sebaceous cyst, which is superficial and is a part of the skin. An atheromatous cystoma is lined with epithelium, but not with skin. A dermoid cyst is lined with skin or other definite structures. An atheroma is due to the displacement of a mass of epithelial cells, which mass was the matrix of the cystoma. "The displacement of the matrix of an atheroma occurred at a time prior to the differentiation of the epiblastic cells into the organs representing the appendages of the skin, while the matrix of a dermoid cyst points to a later displacement of the matrix" ("Pathology and Surgical Treatment of Tumors," by Nicholas Senn). Atheromatous cystomata may be congenital, but may not appear until puberty or even much later.

Treatment.—Extirpation of the wall of the cystoma.

Mucous Cystomata.—A mucous cystoma, like an atheromatous cystoma, is due to the displacement of epithelium, but in the former condition it is pavement epithelium and in the latter it is columnar epithelium. The one is filled with fatty débris and the other with a mucoid material. Such a mucous cystoma must not be confused with a retention-cyst of a mucous membrane. Mucous cystomata are found particularly about the lips, mouth, and pharynx. They rarely attain any considerable size. Cystomata lined with ciliated epithelium may arise in the testicle, the liver, and the brain.

Treatment.-Incise, cauterize, and drain. The wall is so delicate that

excision is rarely possible.

Mesoblastic Cystomata.—They are lined with endothelial cells. They contain serous fluid, often grow to a large size, and sometimes disappear spontaneously. Mesoblastic cystomata are probably distended lymph-spaces. They are congenital and are most common in the neck, axilla, and perineum. In one case seen by the author such a cystoma of the neck appeared late in life, but it is probable that it had existed in childhood, and after disappearing for a long time had reappeared. The most common form of mesoblastic cyst is known as hydrocele of the neck.

Treatment.—Excision is very difficult. In one case in which I assisted Professor Keen it was successfully accomplished. The usual treatment is to tap frequently, after each tapping washing out with carbolic acid (2 to 5 per cent.), and applying pressure.

Cystomata of bone, of the thyroid gland, of the mammary gland, etc., are

considered in the sections on Regional Surgery.

Teratomata.—The teratomata contain tissues or higher structures derived from two or all of the blastodermic layers. The tumors we previously considered are derived from only one of these layers. The elder Senn, in his work on "Tumors," thus defines a teratoma: "A teratoma is a tumor composed of various tissues, organs, or systems of organs which do not normally exist at the place where the tumor grows. The highest type of a teratoma is a fœtus in fœtu. In the simpler varieties the tumor is composed of heterotopic tissue, such as bone, teeth, skin, mucous membrane, etc. All teratoid tumors are congenital; that is, the tumor either exists at the time of birth or the patient is born with the essential tumor matrix. A teratoma never springs from a matrix of post-natal origin." Any human structure may be found in a teratoma. Various fetal malformations belong to this group, as do also



Fig. 165.—Hydrocele of neck in boy nine weeks of age.

double monsters, in which one of the embryos is rudimentary. Teratomata are divided into external and internal. To the external teratomata belong the parasitic fetus and the suppressed fetus. A parasitic fetus is the result of fusion of two embryos, one having gone on to complete development, and the other developing partially, and obtaining nutrition from the fully developed embryo to which it is attached. A suppressed fetus is an irregular mass attached to the posterior surface of the sacrum, the chest, or abdomen. It contains a conglomeration of tissues and fragments of organs, for instance, bone, cartilage, lung tissue, kidney tissue, a piece of intestine, or a portion of liver. In a case pictured by Sutton a leg projects from the sacral region.

An internal teratoma may be found in the cranium, chest, abdomen, or pelvis. The internal teratoma consists of a conglomeration of the tissues and visceral fragments of a suppressed fetus, but, unlike the external teratoma, it is surrounded by a cyst wall. The members of this group most often seen by

the surgeon are dermoid cysts.

Dermoid Cysts.—These cysts were first studied and described by Lebert. The name "dermoid" implies that the cyst contains skin, and it does contain skin or mucous membrane, the chief mass of the tumor being derived from proliferation of the cells of a portion of displaced epiblast or hypoblast, but it also contains mesoblastic derivatives. There are two varieties of dermoid: sequestration dermoid and the tubulo-dermoid. In this section we speak of the first form. The second form is considered on page 398. A superficial dermoid is formed by the inclusion in mesoblastic tissues of a portion of the epidermis or mucous membrane. Superficial non-traumatic dermoids are situated in the region where the blastodermic layers were in contact. A deep dermoid is formed from a collection of epithelial cells completely separated from the epiblastic tissue from which they originated. When a cyst originates from epiblastic cells so immature that the skin appendages have not as yet been formed, it will contain only atheromatous material like that found in a sebaceous cyst. When a cyst arises from epiblastic cells after



Fig. 166,-Traumatic dermoid cyst.

they have so matured that the appendages of the skin have been formed, it will contain atheromatous matter, sweat, sebaceous matter, and hair. The first form is known as an atheromatous cystoma; the second, as a dermoid. A deep-seated dermoid may contain also such structures as prove it must have taken origin from "a displaced matrix representing different tissues and organs" (Senn). Such a dermoid may contain portions of organs, bone, cartilage, and teeth. A dermoid cyst may be defined as a heterotopic cyst, the wall of which is composed of connective tissue lined with epithelium and containing material formed by the proliferation of epithelium and often hair, teeth, or even bone. An injury may displace a bit of epithelium and lodge it in connective tissue and from this a traumatic dermoid may arise (Fig. 166). Garrè called them traumatic epithelial cysts (Fig. 166). They are most often encountered in the palmar surface of the hand or fingers. The skin above such a cyst is not adherent to it and often a scar is visible. The cyst wall is composed from without inward of connective tissue and epithelial cells, the stratum corneum being the inner layer (Leo Buerger, in "Annals of

Surgery," August, 1907). The cyst contains desquamated epithelium and often cholesterin. The causal injury is usually a puncture, but may be a laceration, a contused wound, or a bite. Sometimes a cyst arises in the track of a healed sinus. Pietzner collected reports of 73 cases ("Ueber Traumatische Epithelcysten. Dissert. Rostock.," 1905).

Dermoid cysts are most commonly found in the ovary and in regions where, during bodily development, the blastodermic layers come in contact; for instance, in the neck, the eyelids, the orbital angles, the lumbosacral region, the root of the nose, and the floor of the mouth. Such cysts are also found in the ovary, testicle, brain, eye, mediastinum, lung, omentum, mesentery, and carotid sheath.

A dermoid of the lumbosacral region may be mistaken for a spina bifida. Sarcoma may form from the connective-tissue elements of the wall of a dermoid cyst. A dermoid cyst may become cancerous, or innocent epithelial tumors may originate from the cyst lining. The epithelial cells may become fatty and an oil-cyst may actually form. If the cyst epithelium was derived from mucous membrane, mucus may gather in the sac. A dermoid cyst may inflame or even suppurate. It is free from pain unless it suppurates, inflames, or develops into a malignant tumor; it grows slowly and rarely attains any considerable size unless it arises in the ovary. Such cysts tend to appear in particular regions. A subcutaneous dermoid may or may not fluctuate. It is not in the skin as is a sebaceous cyst, but the skin can be moved over it. A sebaceous cyst moves with the skin. Subcutaneous dermoids about the orbit are adherent to the underlying periosteum. The matrix of a true dermoid is congenital, but the cyst often does not appear until puberty or later. Teratoids and dermoids connected with the rectum require special consideration (page 1160).

Treatment.—Complete extirpation. If any of the epithelium of the cystwall is left, the cyst will re-form. A superficial dermoid should be removed in the same manner as a sebaceous cyst, and if it is adherent to underlying periosteum the portion of this membrane to which it adheres should also be removed. A deep dermoid ought to be removed as a tumor would be if operation is feasible.

Branchial Cysts and Fistulæ.-When a branchial cleft fails to become completely obliterated, a branchial cyst may form. The branchial clefts are the analogues of the gill-slits of a fish. There are four of these clefts on each side of the neck. They are called clefts, but they are really grooves, and each groove on the skin has its counterpart in the mucous membrane of the pharynx. Each pharyngeal groove is covered with hypoblastic epithelium; each cutaneous groove is covered with epiblastic epithelium, and the two grooves are separated by mesoblastic structures. When the sides of a cleft do not unite and an opening forms in the mucous membrane, a complete branchial fistula (complete congenital cervical fistula) results. When the sides of a cleft fail to unite and, although the mucous membrane is not perforated, the skin does not cover the cleft, a branchial sinus or an incomplete branchial fistula (incomplete congenital lateral cervical fistula) results. When the sides of a cleft toward the pharynx fail to coalesce, a pharyngeal diverticulum is produced. When the pharyngeal surface and the cutaneous surface both close, but the deeper part of a cleft remains open and epithelial cells are caught in mesoblastic elements,

a branchial cyst is formed. Sinuses are more common than complete fistulæ or cysts.

The essential cellular element of a branchial cyst is epithelium, derived either from the skin or pharynx; hence the branchial cyst is not a dermoid, because its histological elements are derived from only one of the blastodermic layers. Branchial cysts are most common in the triangle of election of the left side. They are round, smooth, often fluctuating, and are very deeply situated, being in close relation with the great vessels. Some cysts contain mucus, others serous fluid, others fatty débris. An abscess may form. The origin of a cyst or fistula is usually from the second branchial cleft, but Flint has reported a fistula of the first branchial cleft ("Annals of Surgery," August, 1908). There may be one, two, or three openings. Not unusually the openings are bilateral. Hereditary tendency is often manifest. The cutaneous openings are always along the anterior margin of the sternocleidomastoid muscle. At the external orifice there is often an irregularly shaped bit of skin and cartilage, which is called a cervical auricle.

Treatment.—In old children and in adults it may be possible to extirpate a cyst or a fistula, although this is very difficult and often impossible. Other methods employed are incision, cauterization with the Paquelin cautery, and packing with gauze; frequent tapping and injection with iodin; incision and drainage, every antiseptic care being observed. In all young children and in some older persons with deep cysts, the latter plan is the only one advised, and it will often fail, but will sometimes produce a cure.

Cysts.—A cyst is a cavity, abnormal or pathologic in character, lined by a membrane and containing material usually fluid or semifluid. It is necessary to bear in mind the distinction between a cystoma and a cyst. Hektoen and Riesman, in "American Text-book of Pathology," insist on this distinction. They say: "A cystoma is a true tumor, arising from active proliferation of a matrix destined to form cystic spaces; whereas a cyst is a secondary formation not primarily due to tissue proliferation." Cysts are divided into the following classes: Retention-cysts; cysts from softening; tubulo-cysts; and parasitic cysts ("American Text-book of Pathology").

Retention-cysts.—A retention-cyst is formed by blocking of the duct of a gland or by failure in the absorption of the proper amount of the secretion of a ductless gland. A few characteristic forms of retention-cysts will be described.

Sebaceous Cysts (Wens).—These arise when the excretory duct of a sebaceous gland is blocked by dirt or occluded by inflammation. The orifice of the duct is often visible as a black speck over the center of the cyst. They are very common in the scalp, being known as wens, and upon the face, neck, shoulders, and back. Arising in the skin, and not under it, the skin cannot be freely moved over a sebaceous cyst. A sebaceous cyst is lined with epithelium and is filled with foul-smelling sebaceous material. A sebaceous cyst may suppurate. When a cyst ruptures and the contents become hard, a horn is formed. Another form of horn has been previously alluded to as due to horny transformation of a wart.

Treatment.—To treat a sebaceous cyst, incise the portion of skin above it, and dissect the sac entirely away with scissors or a dissector, trying not to rupture the delicate wall. If even a small particle of the wall is left, the cyst will re-form. If it ruptures during removal and it is feared that some portion

may remain, paint the interior of the wound with pure carbolic acid. If acid is not used, close without drainage; but if acid is used, drain for twenty-four hours. If an abscess forms in a sebaceous cyst, open it, grasp the edges of the cyst-lining with forceps, dissect out this lining with scissors curved on the flat, cauterize with pure carbolic acid, and drain for twenty-four hours.



Fig. 167.-Multiple sebaceous tumors of the scrotum (Horwitz).

Mucous Cysts.—A mucous cyst is due to the blocking of a mucous gland or a mucous crypt. Mucous cysts occur particularly in the mucous membrane of the mouth and genito-urinary organs, and are filled with thick, adhesive mucus containing numerous epithelial cells. Such a cyst is of spherical outline, and the epithelial membrane which lines it is strongly adherent to tissues beyond.

Treatment: Incision, curetment, cauterization with pure carbolic acid, and packing or extirpation of a considerable part of the cyst, and curetment and cauterization of the part remaining.

Oil Cysts.—An oil cyst is due to fatty degeneration of epithelium lining a sebaceous cyst, or a milk cyst of the breast. As previously noted, a dermoid may result in an oil cyst.

Treatment: Extirpation, as for sebaceous cysts.

Salivary Cysts.—A retention-cyst of a salivary gland is known as a ranula (q. v.). These cysts are most common in the submaxillary or sublingual gland.

Lacteal or Milk Cysts.—Such a cyst occasionally arises in the mammary gland during lactation, and is the result of blocking of a lactiferous duct (see Cysts of Mammary Gland).

Among other forms of retention-cysts, most of which are discussed in special sections of this book, we mention hydrosalpinx, a cyst due to blocking of a Fallopian tube; cysts due to obstruction of the bile-ducts (the most com-

mon form is known as hydrops, which is a dilated gall-bladder the result of obstruction); cyst of the thyroid gland; cyst of the pancreas; and hydronephrosis, a condition produced by obstruction of the ureter.

Cysts from Softening.—These cysts are formed by the disintegration of degenerated tissues. For instance, after a hemorrhage into the brain, softening may follow and a cyst arise. Cystic changes of this sort are frequently observed in sarcomata and carcinomata. A cyst from softening has a wall of connective tissue, but there is no endothelial or epithelial layer.

Tubulo-cysts.—This name was given by J. Bland Sutton to cysts formed in certain remains of embryonal ducts, which vestiges in the developed body ought to have been destroyed. A small cavity is left unobliterated, and in this space fluid gathers. The source of the fluid is usually the lining cells of the cavity. Branchial cysts are frequently considered under this heading. Among the commoner tubulo-cysts are cysts of the vitello-intestinal duct, cysts of the urachus, and thyroglossal cysts. Thyroglossal cysts and sinuses are considered on page 922.

Mesenteric cysts, not hydatid and not due to carcinoma, are embryonic developments from remains in the mesentery of the vitelline duct, the Wolffian ducts, the Wolffian bodies, and the Müllerian ducts (Moynihan).

What are called "chyle cysts" of the mesentery are embryonal cysts placed in such close adjacency to lacteals that chyle enters into them (E. P. Baumann,

in "Lancet," May 7, 1904).

Cysts of the Vitello-intestinal Duct.—Such a cyst presents itself as a small, bright red, globular mass, which appears to arise from the umbilicus of a baby or a young child, and which usually has a distinct pedicle, but may be sessile. A cyst of this character forms when the vitello-intestinal duct atrophies from the gut toward the umbilicus, but a remnant at the umbilicus escapes obliteration, and from this remnant a cyst forms. The wall of such a cyst contains unstriped muscular fiber and is lined with mucous membrane. Occasionally the duct in the process of involution is not destroyed,—its caliber is simply lessened,—and the duct remains open in the navel and feces come from it. If the duct fails of obliteration at the intestinal end, a diverticulum remains at this point (Meckel's diverticulum).

Treatment.—A pedunculated cyst at the navel is treated by ligating its base and cutting the stalk beyond the ligature. A cyst with a thick base is dissected out. The surgeon must be careful to avoid confounding an umbilical hernia with a cyst of the navel.

Urachal Cysts.—The urachus is the obliterated allantois and is a cord running from the summit of the bladder to the umbilicus. This structure is in the middle line of the abdomen and in front of the peritoneum. A portion of the allantois may not be obliterated at birth, and in consequence of this failure a cyst forms. It grows to a considerable size, may push the peritoneum away and reach the pelvis, may communicate with the bladder, may break through the umbilicus or grow backward toward the spine.

Treatment.—Extirpation of the lining membrane, partial closure of the cavity by suture, and packing the unobliterated part. Complete extirpation of the cyst is seldom attempted. W. R. Weiser ("Annals of Surgery," Oct., 1906) collected 86 cases of cyst of the urachus. In 8 of these complete extirpa-

tion was performed and Macdonald has since reported a successful complete extirpation ("Annals of Surgery," August, 1907).

Parasitic Cysts.—Parasitic cysts are due to the development of certain parasites in the tissues. The form most often encountered is known as hydatid disease.

Hydatid cysts are especially common in Iceland, and are frequent in Australia and South America, but are very rare in the United States. In the United States or per cent, of cases occur in foreigners (Lyon). Hydatid cysts are due to echinococci. The adult echinococcus is the tapeworm of the dog (tænia echinococcus), and its ova or larvæ gain access to man's body by accompanying the food he eats and passing into the alimentary canal, from which situation they are transported to various organs by the blood. Osler says the embryo (which has six hooklets) burrows through the wall of the bowel and enters the peritoneal cavity or muscles; it may enter the portal vessels and reach the liver, or may enter the systemic circulation and pass to distant parts. The danger depends on two factors: "the situation and the liability of the cyst to suppurate" (Sidney Coupland). The organs most usually attacked are the liver and lung. In 60 per cent, of cases the liver suffers, and in 12 per cent. the lung (Thomas). Lyon estimates that the liver is the seat of disease in 73 per cent. of cases. Cysts sometimes arise in the intestine, genito-urinary passages, brain, or spinal canal. When the embryo lodges, the hooklets disappear and a cyst is formed. This cyst is composed of two layers, an outer capsule (cuticular membrane) and an inner layer (endocyst). The cyst contains clear saline fluid. As the cyst grows, daughtercysts bud out from the wall of the mother-cysts, the structure of the daughtercysts being identical with that of the mother-cysts. From the lining membrane of all the cysts, after a time, growths arise known as scolices, which represent the head of the echinococcus and exhibit four sucking disks and a row of hooklets (Osler).

The fluid is not albuminous, is occasionally saccharine, is thin and clear, and may contain scolices or hooklets.

A hydatid cyst may calcify, may rupture, or may suppurate. These cysts are very firm, but usually fluctuate. Palpation with one hand while percussion is practised with the other gives a persistent tremor (hydatid iremitus). If the cyst can be safely reached, some fluid should be drawn and examined for diagnostic purposes. When a cyst suppurates, positive constitutional and local symptoms arise. Hydatid cysts of the brain and cord tend to produce death in the same manner as do tumors. A cyst of the liver may rupture into the pleural sac, into the belly cavity, into the stomach, or into the bowel, producing shock, hemorrhage, and probably death. In rare cases hydatid cysts rupture into the pericardium or into a great abdominal blood-vessel, or externally. Rupture into the bile-passages is usually followed by suppuration of the cyst. Suppuration of a cyst may follow uncleanly tapping. It has been recently pointed out that eosino-philia is noted in most persons suffering from hydatid disease.

Treatment: An unruptured hydatid cyst of a superficial structure should be incised and the sac-wall should be dissected out. Hydatids of the brain have been successfully removed in Australia. A cyst of the kidney is removed through a lumbar incision. Omental cysts should be radically removed if possible; if this is not possible, open the abdomen, surround the cyst with gauze, evacuate through a trocar, stitch the cyst-wall to the wound, incise, irrigate, and drain with gauze. Bond advocated evacuating the cyst, closing it with sutures, and dropping it back in the abdomen. Gardner says tapping is dangerous, as it may cause rupture of the cyst. In a hydatid of the liver the abdomen should be opened, the cyst should be surrounded with gauze pads, and tapped with a trocar and cannula. When the cyst is emptied of fluid it is grasped with forceps and pulled to the incision in the abdominal wall; it is sutured to this incision, the trocar opening is enlarged, and the endocyst is removed by irrigation.\* This operation is called marsupialization. If the cyst is on the summit of the liver, it may be reached by a transpleural hepatotomy. If aspiration is performed to settle a diagnosis, operate at once after doing it, because of fear that the cyst may leak and disseminate the disease throughout the peritoneal cavity. If hydatid fluid is disseminated throughout the peritoneal cavity, it may or may not lead to the development of new cysts, but it is almost certain to cause a febrile condition known as hydatid toxemia. Brewer ("Annals of Surgery," April, 1908), in operating on a case of hydatid cyst of the liver, wounded the portal vein and was obliged to tie it. The patient recovered. That there was no failure of nutrition Brewer attributes to the fact that the vein had been long pressed upon and the collaterals were dilated when ligation was performed.

<sup>\*</sup> John O'Conor, of Buenos Ayres, in Annals of Surgery, May, 1897.

## XVIII. DISEASES AND INJURIES OF THE HEART AND VESSELS.

Heart and Pericardium.—In acute pulmonary congestion the venous side of the heart is overdistended with blood, and the surgeon in desperate cases may tap the right auricle (see Paracentesis Auriculi). Pericardial effusion, if severe, calls for aspiration or incision, and purulent pericarditis

demands incision and drainage.

Rupture, Wounds and Injuries. - Rupture. - The heart may rupture and cause instant death, but rupture may not be instantly fatal. Curtin reported a case in which death did not occur for over twenty-four hours. Elsner reported a case of rupture in which life was prolonged for ten days. One case lived eleven days. In cases in which death does not occur rapidly the rupture must be so small that very little blood escapes. Rupture occurs in a damaged heart, a heart in which the muscular fiber is fatty, is fibroid, or is necrotic from suppuration. It may be traumatic, resulting from a fall or a blow upon the chest, or non-traumatic, following a great effort or strain. If death does not at once take place the pulse becomes very rapid, there is precordial pain, dyspnea, cyanosis, feeble heart-sounds, rapid respiration, great restlessness, collapse, and syncope, and the development of a triangular area of dulness. Positive diagnosis is impossible. Meyer collected 36 cases of rupture of the heart reported since 1870. Death occurs from accumulation of blood in the pericardium. Aspiration is useless, as fresh blood replaces what is withdrawn. Suturing must fail in non-traumatic cases because of the badly diseased myocardium. In traumatic cases it may possibly succeed.

Wounds of the Pericardium and Heart.—Severe wounds usually, though not always, produce death, but slight wounds may not prove fatal. It is a popular impression that the expression "stabbed to the heart" is another way of saying that instant death has occurred. This view was accepted even by surgeons during many centuries. During the sixteenth century sportsmen found now and then bullets and arrow-tips healed in the heart-walls of animals they had slain. At this time the famous case of a duelist was published by Paré. This man received a sword thrust in the heart, but was able to run after his opponent many hundred feet before falling down in death. (See "An Experimental Investigation of the Treatment of Wounds of the Heart," by Charles A. Elsberg, in "The Journal of Experimental Medicine," Sept. and Nov., 1899.) From Paré's time until our own it has been recognized by surgeons that a wound of the heart does not of necessity produce immediate

death and may even be recovered from.

In 1867 G. Fisher published a study of 452 cases of wound of the heart, and pointed out the surprising fact that from 7 to 10 per cent. of such cases recover. In recent years Rosenthal, Block, Del Vechio, and others have proved by animal experimentation not only that cardiac wounds are not of necessity instantly fatal, and that in some cases they may be recovered from, but that the suturing of such wounds is possible and greatly enhances the chance of recovery. L. L. Hill ("Med. Record," Nov. 29, 1902) shows that although 90 per cent. of heart-wounds are penetrating, only 19 per cent. are

immediately fatal. Sudden death occurs when Kronecker's coördination center is damaged. Several times during post-mortem examinations on human beings healed scars have been found upon the heart. The heart has been punctured a number of times accidentally or intentionally, and death has not ensued. John B. Roberts,\* of Philadelphia, suggested in 1881 that it would be proper to try to suture wounds of the heart.

Symptoms.—A wound of the heart causes hemorrhage, usually copious: but owing to the interlocking of muscular fibers the hemorrhage is often slight. Bleeding may take place into the pericardial sac in some cases where the pericardium has been injured and the heart has escaped. Such an injury is occasionally inflicted by the sharp end of a fractured rib. The wound is rarely at or near the apex of the sac. In most cases the pleural cavity is opened and severe hemothorax occurs. The lung may or may not be injured. A wound of the pericardium or heart causes profound shock, irregular or very weak pulse, sighing respiration, dyspnea, and, it may be, the signs of hemopericardium, pneumopericardium, or hemothorax. In hemopericardium splashing sounds are heard with the heart-beats and the heart sounds are very feeble. In pneumopericardium there is a tympanitic percussionnote in the area which should exhibit the cardiac dulness. may not be serious external bleeding. Fatal concealed hemorrhage may occur. Pain is constant, and attacks of syncope are the rule. The position of the wound and the evidences of hemorrhage may aid in making the diagnosis. Death is apt to occur suddenly from shock, hemorrhage, and inability of the heart to contract because of the severed fibers, or inability of the heart to dilate because of the pressure of blood in the pericardial sac. If a wound of the pericardium or heart does not cause death during the first day or two inflammation follows (traumatic pericarditis or carditis) and the patient may die of suppurative pericarditis or of empyema.

Treatment.-Wounds of the pericardium and heart should be sutured. We should explore if, from the location of the wound and the symptoms, we suspect a cardiac wound. I agree with Vaughn, that if there is a wound in the cardiac region and if the symptoms threaten life, exploration should be performed at once. In a doubtful case exploration should be made by enlarging the wound and should be done under local anesthesia. In operating for a heart-wound the cutaneous surface should be rapidly disinfected, and every effort must be made to antagonize shock during the operation. The patient should be wrapped in hot blankets and surrounded with hot bottles or hotwater bags, or should be placed upon a table composed of pipes in which hot water circulates. The foot of the bed should be raised. Hot saline fluid containing adrenalin chlorid should be infused into a vein, or, in desperate cases, into an artery. The extremities, except the one selected to infuse salt solution in, should be bandaged (autotransfusion), an enema of hot coffee and whisky should be given, and atropin should be injected hypodermatically. It is wiser, in most cases, to give a general anesthetic than not to give it. Local anesthesia is slow and unsatisfactory. Without an anesthetic the patient will probably struggle, and struggling is very dangerous, as it loosens clots and permits hemorrhage to begin again (L. L. Hill, in "Med. Record," Sept. 19, 1908). Chloroform is the anesthetic used. If the patient is unconscious and the corneal

<sup>\*</sup>The author, in Progressive Medicine, vol. i, 1899.

reflex is abolished, no anesthetic should be given. The heart is exposed by resecting several ribs. In a knife-wound of the right pleural cavity and right side of the pericardium, Barth, of Danzig, removed 1 inch from each of three right costal cartilages (fifth, sixth, and seventh), close to the side of the sternum, and removed also the ensiform cartilage and 1 inch of the sternum. The same surgeon, in the case of a man stabbed in the fourth left intercostal space, removed the fourth and fifth left costal cartilages and part of the sternum ("Deutsche Zeitschrift für Chirurgie," Bd. lxix, No. 1). Schwerin, of Berlin, in a stab-wound of the chest exposed the heart by resecting the fourth and a portion of the fifth left ribs (Proceedings of German Surgical Congress, 1903). Wilms ("Centralblatt f. Chirurgie," Leipzic, vol. xxxiii, No. 22), in a case of gunshot-wound, obtained access to the anterior and posterior surfaces of the heart by a simple intercostal incision. Parrozzani makes a trap-door in the chest, the hinges of the door being the rib cartilages. In exposing the heart Giordono enters along the wound, removing any obstacles that intervene (Barth). It is needless to try to avoid opening the pleura if a flap with an internal hinge is used; it has usually been opened by the accident, and in any case can very seldom be avoided. Matas advises Spangaro's intercostal incision. The mammary vessels are tied and the width of the intercostal space is greatly increased by strongly retracting the ribs and cartilages. If more space is needed the incision is carried upward at the junction of the cartilages and sternum. The heart is exposed, clots are removed from the pericardial sac, and the sac is irrigated with hot saline fluid. The bleeding may be furious. A non-penetrating wound of the ventricle may bleed so profusely during systole as to resemble a penetrating wound (Sherman). A penetrating wound may bleed most during diastole. The motions of the chest make manipulation difficult. It is wise to insert two traction sutures in order to lift the heart toward the operator. A wound in the heart is sutured with interrupted sutures of catgut, which are passed by means of a round, curved needle, and if a cavity of the heart is open each suture includes the whole thickness of the heart-wall except the endocardium. It has been said that the sutures should be tied during diastole, otherwise they are apt to cut out, but Profs. Gibbon and Stewart tell me that in their cases such a procedure was impossible because of the very rapid action of the heart. As few stitches are used as will efficiently close the wound. Numerous stitches cause extensive degeneration of muscular fiber and stitch holes may permit leaking. The pericardium is sutured with silk or, as was done in one successful case (Rehn), the sac is packed with iodoform gauze. It is not absolutely necessary to drain the pericardial sac. Clots are removed from the pleural sac by irrigation with hot saline solution, pulmonary bleeding is arrested by the suture or by packing, and a wound in the lung, especially if it communicates with the air-passages, is sutured if the patient's condition justifies prolonging the operation.\*

After such an operation the patient is in great danger and every effort should be made to save him from shock. In performing operations upon the heart the pleura is almost always opened, and if it is open there is always pneumothorax and grave danger of pulmonary collapse and overwhelming shock. It is a great advantage in such cases to have at hand an apparatus which will prevent or amend pulmonary collapse (see page 804).

<sup>\*</sup> The author, on "Suture of the Heart," in Progressive Medicine, vol. i, 1899.

One hundred and sixty cases of heart suture are now upon record. In 1881 Dr. John B. Roberts, of Philadelphia, suggested that heart-wounds should be sutured. In 1887 Dr. Harvey Reed sutured a wounded pericardium and the patient recovered. In 1891 Dalton, of St. Louis, obtained recovery by a similar operation. The first operation on a wounded human heart was performed in 1896 by Farina, of Rome. The patient had been stabbed in the right ventricle. The wound was sutured, but he died of pneumonia on the sixth day. Rehn, of Frankfort, in 1896 sutured a wound of the heart and packed the pericardium with gauze, and the patient recovered. Among others reporting cases are Cappelan, Peyrot, Williams, Barth (in this case the internal mammary artery was also injured), Wilms, Hill, Sherman, Harte, Gibbon, Stewart, Guinard, Sultan, Cumming and Beattie, Wolff, Picqué, Lenormand, and Parozani. There have been 3 successful cases in Philadelphia, Gibbon's case and Stewart's 2 cases. I have never operated for a wound of the heart. According to Hill, the right ventricle is most often, the left auricle least often, injured; wound of the auricle is generally considered to be more dangerous than wound of the ventricle; and wound of the apex is less dangerous than either. Peck points out, however, that there are 11 reported cases of auricle wounds with 4 deaths, a mortality of 36.3 per cent., while the general mortality of heart wounds is about 64 per cent. ("Annals of Surgery," July, 1909). A needle puncture rarely causes serious bleeding from a ventricle, but is very apt to cause severe bleeding from an auricle. A wound received during diastole is less dangerous than one received during systole. Wounds of the right heart bleed more than wounds of the left heart. Wolff points out that ligation of one coronary artery can be done and recovery follow; wounds of the left ventricle give the best prognosis because the wound is closed by thick edges of muscle; in 37 cases the left pleura was opened, in 3 the right pleura, and in 2 the pleura was uninjured. In bulletwounds death usually occurs before operation can be done (Wolf, "Deutsche Zeitschrift für Chirurgie," Bd. lxix, No. 1). Without operation the mortality will be at least 90 per cent. With operation it will be about 60 per cent.

Matas ("Southern Med. Jour.," August, 1908) discusses 160 cases of heart wound with 43.83 per cent. of recoveries. In 134 cases the wound was sutured with 49 recoveries. In 11 cases it was exposed, but was not sutured, and 5

recovered. In 5 cases foreign bodies were removed with success.

In Peck's table ("Annals of Surgery," July, 1909) there are 69 wounds of the right ventricle with 48 deaths (69.6 per cent.); 74 of the left ventricle with 45 deaths (60.8 per cent.); 5 of the left auricle with 2 deaths (40 per cent.); 6 of the right auricle with 2 deaths (33.3 per cent.); and 7 miscellaneous cases with 5 deaths (71.5 per cent.), a total of 160 cases with 58 recoveries and 102 deaths; a mortality of 63.7 per cent.

The immediate dangers of the operation are hemorrhage, shock, and the entrance of air. The late dangers are pericarditis, empyema, and pneumonia (Vaughan). Traumatic carditis or pericarditis is treated in the same way as idiopathic cases. Pus in the pericardial sac should be evacuated by resection of the fourth left costal cartilage and incision of the pericardium (von Eiselberg's case).

Pericarditis.—Pericarditis is an infectious condition that may be traumatic or non-traumatic. If pericarditis follows an open wound, it is

obvious how the infection must have entered; if it follows a bruise or a contusion, the injury has rendered the pericardium a point of least resistance. In some few cases, which are known as primary pericarditis, it is impossible to determine how the micro-organisms gained entrance. The ordinary form appears as a complication of certain infectious diseases, such as septicemia, pneumonia, rheumatism, and tuberculosis. It may be secondary to some adjacent infection, such as an empyema. A tuberculous abscess may break into the pericardium, and an abscess even from a distant point may burrow into it. It may arise secondary to a distant infection, as a suppurating wound, osteomyelitis, middle-ear suppuration, abscess of the mastoid, tonsillitis, abscesses anywhere, peritonitis, and gastric ulcer. It sometimes follows gastro-enterostomy and may arise in an individual with Bright's disease. In a recently born child infection of the stump of the umbilical cord may cause pericarditis. A pericardial effusion in a newborn child is invariably purulent and in a young child it is usually purulent. In children the condition is usually associated with pulmonary disease (Poynton, in "Brit. Med. Jour.," August 15, 1908). A great variety of bacteria may be responsible for pericarditis. The exudation may be serofibrinous; this is an evidence of its being a mild infection, and such an exudate may undergo absorption. On the other hand, the exudate may become purulent, and in such a case cure will never be obtained by absorption of the pus. In pericarditis there is usually some pain in the region of the heart, and this pain is apt to extend into the left arm. The heart is overacting, the heart-sounds are indistinct, the pulse is strong and very rapid, there is an increased area of cardiac dulness, and the patient complains of dyspnea. The temperature is elevated and a double friction-sound may be made out upon auscultation.

Treatment.-Ordinary pericarditis, without pus formation or extensive effusion, is managed by the physician; but when there is extensive effusion it may be necessary to open the pericardium, and if there is purulent effusion the pericardium must be opened. The procedure usually practised in the past to relieve pericarditis with marked effusion was aspiration. This, however, is dangerous. The heart is not, as formerly taught, pushed back and up by the pericardial effusion, but is lifted upward and forward, and may be pushed to the right or left if there are adhesions between the pericardium and heart; and it is impossible to select any place for aspiration that assures us that there will be no danger of puncturing the heart. Le Conte and many other surgeons, however, do not fear puncture and explore by inserting a fine needle in the fourth or fifth space of the left side close to the sternum. In cases of extensive pericardial effusion, and also in cases of suppuration within the pericardium, I believe that 1 inch or more of the cartilage of the fourth rib of the left side should be removed or 2 inches of the fourth rib itself, and the pericardial sac should be exposed and, after exploratory puncture, formally incised. In this operation it may be necessary to tie the internal mammary artery. In pyopericardium the pleural cavity is very seldom invaded because the pleural space in front of the pericardium has usually been obliterated by the spread of the inflammation. The pericardial sac is cleared of purulent material and fibrinous masses by irrigation, and the edges of the pericardial wound are sutured to the edges of the superficial wound and gauze drainage is introduced. Incision is safer and more certainly

curative than aspiration; for whereas aspiration might be curative in pericardial effusion, it cannot be so if the effusion is purulent. In 41 cases of purulent pericarditis (Roberts' table of 35 cases and Ljunggren's 6 cases) operated upon, 16 recovered. Local anesthesia is safer than general anesthesia.

Phlebitis, or Inflammation of a Vein.-Acute Phlebitis.-Phlebitis may be plastic or it may be infective. Plastic phlebitis, while occasionally due to rheumatism, to gout, to advanced phthisis, to a febrile malady, or to some other constitutional condition, usually takes its origin from a wound or other injury, from the extension to the vein of a perivascular inflammation, or, in the portal region, from an embolus. Varicose veins are particularly liable to phlebitis. When phlebitis begins a thrombus usually forms (see Thrombosis, page 199) because of the destruction of the endothelial coat of the vessel, and this clot may give rise to emboli, may be absorbed, or may be organized. An aseptic clot organizes and the vein becomes permanently narrowed or blocked. A septic clot is apt to soften and break up. In the lower extremities paraphlebitis is common with slight involvement of coats, and a clot may not form. Clot-formation causes edema. Infective phlebitis is a suppurative inflammation of a vein arising by infection, perhaps from suppurating perivascular tissues (infective thrombophlebitis), perhaps from the blood-stream, or in the portal system, perhaps from infective embolism. It is not unusually met with in cellulitis or phlegmonous erysipelas, may arise in the lateral sinus as a result of mastoid suppuration, or in the liver from appendicitis or phlebitis of the rectal veins. Sometimes as the convalescence from pneumonia begins, phlebitis arises due to pneumococci. A thrombus forms, the vein-wall suppurates, is softened and in part destroyed, and the infected clot softens and gives rise to emboli. No bleeding occurs when the vein ruptures or is opened, as a barrier of clot keeps back the blood-stream. The clot of suppurative phlebitis cannot be absorbed and cannot organize. Septic phlebitis causes pvemia, and the infected clots of pyemia cause phlebitis at the points of lodgment.

Post-operative phlebitis of the iliac, femoral, or saphenous veins is not commonly the result of a mild or attenuated infection, but may follow an abdominal operation when there is no evidence of infection. According to Cordier, it occurs in 2 per cent. of abdominal operations. Strange to say, it is most apt to attack the left iliac, femoral, or saphenous veins; it matters not upon which side the operation was performed. In over 90 per cent. of cases the left femoral or left saphenous veins are attacked (Cordier, in "Jour. Am. Med. Assoc.," Dec. 9, 1905). It is most common in anemic subjects, especially when anemia results from blood loss. It may be due to toxins damaging the inner coat of the vein, but feeble circulation is a powerful factor in its production. I believe, with Clark, that powerful traction on the sides of an abdominal wound may be responsible for it (see Thrombosis after Abdominal Operations, page 202). Vanderveer reported 4 cases in which sepsis was positively absent ("American Medicine," July 13, 1901). I have seen it occur in the left iliac vein after an interval operation for appendicitis. Phlebitis may arise in the vein of one extremity, a clot may form, and this may be absorbed or may organize. Another extremity may be involved afterward or simultaneously. Post-operative phlebitis is sometimes responsible for embolic pneumonia and cerebral embolism. Many post-operative pneumonias are due to this cause.

Symptoms.—The symptoms of plastic phlebitis are pain, tenderness in and around a vein, discoloration over it, and edema below the seat of the disease. Suppurative phlebitis, besides these conditions, causes the constitutional symptoms of pyemia (page 212). Any thrombus, if it loosens, forms emboli. It is said that the clot resulting from pneumococcic phlebitis forms so rapidly that it adheres slightly and is peculiarly apt to loosen and give rise to emboli (Pierre, in "Gazette des Hôpitaux," Sept. 3, 1904). Septic thrombi are apt to cause septic pneumonia.

Treatment.—The treatment of plastic phlebitis of an extremity comprises rest in bed from four to six weeks, slight elevation of the part, the use of cold for the first twenty-four hours, and then the application of external heat and a flannel bandage. If the patient is gouty or rheumatic, appropri-



Fig. 168.-Varicose veins.

ate remedies should be given. A clot does not always form in an inflamed vein, but if one forms there is danger of embolism; hence massage and both active and passive movement are dangerous until the clot becomes firm. When a vein is involved in a suppurative process and septic thrombophlebitis exists, ligate or compress the vein by packing, if possible, above and below the clot, open the vessel, and wash out the infected clot, or, if dealing with an accessible vein, extirpate the involved portion. This plan of treatment is always to be applied in infective thrombophlebitis of the lateral sinus and of the internal saphenous vein. The constitutional treatment is that of pyemia.

Chronic Phlebitis.—This rare condition is known as phlebosclerosis, and it is a chronic inflammation of the wall of a vein, producing a fibrous

change in the vascular coats. It may arise in a part the seat of chronic venous engorgement, but its most frequent cause is syphilis. It is met with often associated with arteriosclerosis.

Varicose Veins; Phlebectasis, Phlebectasia, or Varix (Figs. 168 and 169).—Definition and Causes.—Varicose veins are unnatural, irregular and permanently dilated veins which are elongated and pursue a tortuous course. This condition is very common, and 20 per cent. of adults exhibit it in some degree in one region or another. Some facts indicate hereditary predisposition. In over 80 per cent. of cases the trouble begins before the age of twenty-five. The causes of varicose veins are said to be obstruction to venous return and weakness of cardiac action, which lessens the pro-



Fig. 169.-Varicose veins.

pulsion of the blood-stream. A. Pearce Gould says obstruction is not a cause, because in pregnancy varicose veins may be seen early, before the womb is much enlarged. The real cause is probably a predisposition to the growth of vein-tissue, which leads to valve failure and a regurgitation of blood from the deep veins into the superficial venous channels (A. Pearce Gould, in "Lancet," March 1 and 15 and June 7, 1902). As Billroth said over thirty years ago, sudden obstruction causes edema and gradual obstruction a free collateral circulation. Neither sudden nor gradual obstruction can cause varicosity unless the veins are predisposed by a tendency hereditary or acquired.

Varicose veins may occur in any portion of the body, but are chiefly met with on the inner side of the lower extremity, in the spermatic cord, and in the rectum. Varix in the leg is met with most commonly during and after pregnancy and in persons who stand upon their feet for long periods. It is especially common in the long saphenous vein, which, being subcutaneous, has no muscular aid in supporting the blood-column and in urging it on. The deep as well as the superficial veins may become varicose. Verneuil maintained that varix of the superficial veins is almost always secondary to varix of the deep veins, a radical view which seems improbable. It is certain, however, that after contusions of the leg it is not unusual for the deep veins to become filled with clot and for the superficial veins to dilate notably. By the term "caput medusa" is meant dilated veins radiating from the umbilicus. The veins of the esophagus may become varicose, and this malady is commonly unrecognized clinically. Varicose veins are in rare instances congenital; but they are most often seen in the aged, and usually are first observed between the ages of twenty and forty. They are more common in women than in men, owing, it is believed, to the influence of pregnancy.

Varix of the spermatic cord is known as "varicocele." It is apt to appear about the time of puberty, and most adult men have at least a slight varicocele. Varix is more likely to appear in the left spermatic vein than in the vein of the right side, because the left spermatic vein has no valves (Brinton).

Varicose tumors of the rectum constitute "hemorrhoids" or "piles." Piles are caused by obstruction to the upward flow in the hemorrhoidal veins, either by obstructive liver disease, enlargement of the uterus or prostate, or the presence in the rectum of fecal masses in a person habitually constipated.

A vein under pressure may dilate more at one spot than at another, the distention being greatest back of a valve or near the mouth of a tributary. The valves become incompetent and the dilatation becomes still greater. Callender has pointed out that varix is apt to begin where the deep vessels join the superficial veins. At this point Treves says three forces meet: the blood-column above, the valve below, and the force of the blood-current. At the spot where the pressure is greatest the vein-wall dilates, and from this dilatation the blood-current is deflected and causes another dilatation higher up and on the opposite side of the vessel. The blood is again deflected and causes another dilatation, and so on (Agnew). The vein-wall may become fibrous, but usually it is thin and sometimes it ruptures. The veins not only dilate, but they also become longer, and hence do not remain straight, but twist and assume a characteristic form. It seems probable that the first step in the process is a growth of new venous tissue (A. Pearce Gould) and then follow lengthening, tortuosity, incompetence of the valves, and dilatation of the vessel.

Delbet\* points out that varicose veins of the leg, which begin in the thigh, result from valvular incompetence; varicose ulcers arise from variations of pressure due to valvular incompetence. This incompetence of the valves does harm by allowing the intravenous pressure to equal the pressure in the arterioles, a condition which arrests capillary circulation, causes congestion, and greatly lowers tissue-resistance. Incompetent valves also favor ulceration by developing a vicious venous circle first described by Trendelenburg. Blood passing through this circle loses nutritive elements. Trendelenburg has described the vicious circle as follows: Blood in the saphenous vein flows toward the periphery instead of toward the center, because of in-

competent valves—it passes into the veins which connect the superficial veins with the deep veins and then enters the tibial and peroneal veins. It passes from the tibial and peroneal into the popliteal and femoral veins, and some of it leaves the femoral vein and again enters the saphenous.

The skin over varicose veins in the leg is often discolored by pigmentation due to red blood-cells having escaped from the vessel and broken up. The tissues around a varicose vein become atrophied from pressure, and it is not unusual to meet with a very large vein whose thin walls are in close contact with skin. In this condition rupture and hemorrhage are probable. When the vein-wall forms a pouch-like dilatation the condition is spoken of as a cyst. Varicose veins are apt to inflame, and thrombosis frequently occurs. When a thrombus forms, emboli may be broken off and carried into the circulation, especially if the patient walks about. The formation of emboli is not nearly so common as a result of thrombosis in a varicose vein as in thrombosis in an undistended and unelongated vessel. In varicose veins of the thigh, however, the chance of embolism following thrombosis is much greater than when the veins of the leg alone are involved. In some elderly people thrombus actually effects spontaneous cure. When a thrombus organizes, more or less calcification is apt to ensue, and a vein-stone or phlebolith is formed. After middle life many varicosities remain stationary or cease to give trouble. The chief complications of varicose veins of an extremity are thrombosis, edema, violent hemorrhage from rupture, phlebitis, eczema, and chronic ulceration.

Treatment.—The treatment of varix may be palliative or curative, but whichever plan is followed, the surgeon should endeavor first of all to remove the exciting cause. An essential part of palliative treatment is to attend to the general health, to keep up the force and activity of the circulation, and to prevent constipation. Massage is useful, especially alcohol frictions, if eczema is absent, and cold baths are always forbidden (Bennett). The patient should exercise regularly in the open air and should lie down for a time, if possible, every afternoon. Instead of lying down for a time during each day, he may sit down and elevate the legs, resting them on a table, and thus assuming a position supposed to be peculiarly American. If there is no pain, distinct discomfort, or edematous swelling, a support is unnecessary, but if these conditions exist it is needed. If a support is required in varix of the leg, use a flannel roller or a perforated rubber bandage applied over a long stocking. Such a bandage supports the veins and drives the blood into the deeper vessels which have muscular support. The use of a rubber pad filled with glycerin and applied over the saphenous vein so as to support the blood-column and act as a valve, has been recommended. Locally, in varicocele, pour cold water upon the scrotum twice a day and order the patient to wear a suspensory bandage. Locally, in hemorrhoids, use injections of ice-water and astringent suppositories. A purely local varix should be excised, because there is always danger of injury, and consequently of hemorrhage or thrombosis. If the superficial veins have dilated because of thrombosis of the deep veins and edema exists, operation is contraindicated, as its performance might lead to permanent edema. If the disease involves the leg only, operative treatment is rarely required and may even do harm. Such cases are operated upon if there are cyst-like dilatations, if thrombi form, and, as

Bennett points out, if a thin-walled vein crosses the tibia, and is thus exposed to the danger of injury and thrombosis.\*

If the leg is involved in the process, and the saphena in the thigh is also varicose, operation should be performed.

If a thrombus forms in a varicose vein, tie the vein above and below the clot, divide the vessel in two places, and remove the vein and the clot within it. Thrombosis of a varicose vein is not so apt to lead to emboli as thrombosis in a non-varicose vein, but it may do so, and the condition is dangerous.

If edema is marked, and increases in spite of properly applied bandages, etc., it probably signifies clot-formation, and the patient should remain in bed until this question is determined. Hemorrhage from a ruptured varicose vein of an extremity is usually readily arrested by compression and elevation.

The radical treatment of varix of the leg often does good, often relieves some annoying condition, but rarely absolutely cures (W. H. Bennett). There are several methods of operation: ligation with excision of part of the vein, exposure and ligation of the vein below the saphenous opening, or circular incision around the leg (see Operations upon Vessels).

Nevus.—(See Tumors.)

Arteritis, or inflammation of an artery, is acute or chronic.

Acute Arteritis.-Slight inflammation is by no means unusual, but severe arteritis is decidedly rare. It may follow direct injury or arise secondarily to a perivascular inflammation. An artery is very resistant to the spread of inflammation, but we sometimes encounter suppurative arteritis in a suppurating area. Arteritis may arise in the course of an infective malady, being produced by germs, but it is also found in intoxications, and is then due purely to toxins. It may occur in the eruptive fevers, in influenza, typhoid fever, acute rheumatism, gout, syphilis, and diphtheria, septicemia and septic intoxication. Ford points out that acute arteritis developing during acute or chronic infections is particularly apt to arise in the lower extremities (Ford, "Thèse de Paris," 1901). Toxins or bacteria usually reach the artery in the main blood-stream, but may be lodged in the vesselwall by the lymph or the flow in the vasa vasorum. The inner coat of a portion of an artery becomes lined with inflammatory exudate and the coats are infiltrated with small cells. Often parietal thrombi form. Sometimes, though rarely, the vessel is completely blocked by thrombosis. In acute suppurative arteritis pus accumulates in the arterial wall, a clot forms in the lumen, and the coats of the vessel undergo necrosis and give way. Violent hemorrhage may thus arise, but often, in thrombo-arteritis as in thrombophlebitis, rupture does not cause hemorrhage. Acute arteritis, if non-bacterial in origin, is usually recovered from with slight structural change. Infective arteritis is recovered from if the causative germ is not very virulent or if the toxin is not present in excessive quantity. Acute arteritis may terminate in arterial obstruction with or without gangrene, permanent dilatation, arterial rupture, or chronic

Symptoms.—The symptoms may be merged with those of an acute or chronic intoxication or infection, or with those of a local perivascular inflammation. In arteritis arising during infections the symptoms appear abruptly and the onset is marked by great pain. Ford studied 18 cases in influenza.

<sup>\*</sup> W. H. Bennett, Lancet, Oct. 15, 1898.

He says it attacks particularly persons over thirty years of age, occurs in one leg or both, arises most commonly during convalescence, but may not begin until the individual is apparently well. There is pain and tenderness over the vessels, low surface temperature, paresthesia, and mottled skin (Ford, "Thèse de Paris," 1901). The artery may be obstructed, and if a large vessel is blocked, the pulse below the clot is lost. The block may be temporary or persistent. Gangrene may follow. Ford points out that if the artery only is blocked, the gangrene is dry; but if the vein also is occluded it may be moist. I have seen two cases of dry gangrene following influenza.

Treatment.—Secure rest in bed; elevate the extremity slightly, relax it, smear the skin over the inflamed vessel with ichthyol ointment, or mercurial ointment, or follow Ford's advice and use methyl salicylate or an ointment of salicylic acid, turpentine, and belladonna. Wrap the part in cotton and surround it with bottles or bags filled with warm water. If a patient is very restless, a splint must be used. It may be necessary to give morphin for pain and any infection or toxemia must be combated with appropriate remedies.

If gout, rheumatism, or syphilis is regarded as causative, proper remedies must be given. It is most important to maintain the secretion of the kidneys. If abscesses form in a septic case, they must be opened and drained. If a large artery of an extremity becomes occluded, raise the foot about two inches from the bed, wrap the foot and leg in cotton wool, apply a flannel bandage from the toes up, and surround the limb with bags of warm water—not hot water. Hot water would take more blood to the region of the block than could be distributed. If gangrene occurs, amputation is necessary.

Chronic Endarteritis (Arteriosclerosis, Atheroma, Arteriocapillary Fibrosis).-By these terms we mean thickening of the walls of the arteries, limited in area or widespread, due to inflammation or degeneration of the middle coat, the media undergoing hypertrophy, and the intima fibrous hyperplasia (Wm. Russell, "Brit. Med. Jour.," June 4, 1904). Atheroma is used to designate the disease when it attacks the large vessels and is characterized by advanced degeneration. Chronic endarteritis is due to increase of blood-pressure. Increase of blood-pressure means increase of arterial tension, because the lumen of the vessels is lessened and the heart works more strongly to urge the blood along, and finally hypertrophy of the middle coat occurs. The persistence of arterial contraction which causes increase of blood-pressure may be brought about by kidney disease, hard work, violent strains, heart disease, care and anxiety, worry and mental strain, habitual gluttony, syphilis, gout, rheumatism, lead-poisoning, diabetes, and acute infections like typhoid fever and influenza. It may arise in an old man who has not suffered particularly from any of the above-named causes, or may occur prematurely from heredity. It is a true saying of Cazalis that "A man is as old as his arteries," and a young man debilitated by syphilitic disease or alcohol may have diseased arteries, and hence be really older than a healthy man of sixty. The aorta, of all vessels, is most prone to suffer. The large vessels are more apt to be diseased than the small, but even the arterioles can be involved. The arteries of the stomach, liver, and mesentery are rarely sclerotic. In arteriosclerosis connective tissue is substituted for the normal elements of the vascular wall and this tissue undergoes hyperplasia and subsequent contraction and induration. If the mass of proliferating fibroblasts undergoes fatty degeneration, atheroma is said to exist, and an atheromatous vessel may be calcified by deposition of lime salts. When fatty degeneration occurs, the endothelium is destroyed, the vessel-wall is damaged, and the blood may obtain access to the deeper coats. Atheroma is a frequent cause of

thrombosis, aneurysm, senile gangrene, and apoplexy.

A sclerosed artery is rigid, non-contractile, and inelastic, and the parts it supplies are cold, congested, and ill-nourished, and often edematous. When the caliber of arteries remains narrowed because of persistent contraction or of arteriosclerosis, the heart is obliged to overwork and in consequence undergoes hypertrophy. The hypertrophied heart finally dilates. If a hypertrophied heart exists with diseased arteries, apoplexy or aneurysm is apt to occur (Nammack, "Med. Record," Oct. 26, 1901). Syphilitic arteritis is characterized by an enormous growth of granulation tissue from the inner coats of arteries of small size (obliterative endarteritis). Calcification of an artery may be secondary to fatty change, or may occur primarily from deposit of lime salts in the middle coat. Periarteritis is inflammation of the sheath and outer coat. An acute arteritis is always local, but a chronic arteritis may be general. If obliterative endarteritis exists in a limb the veins are almost certain to be involved as well as the arteries. For this condition of veins and arteries, Buerger suggests the term thrombo-angiitis obliterans (" Jour. Am. Med. Assoc.," April 24, 1909).

Treatment of Chronic Arteritis .- In treating chronic arteritis, endeavor to antagonize the dangers to which the patient is obviously liable. Forbid alcohol as a beverage, though a little whiskey may be taken at meals to aid digestion. Maintain the activity of the skin by daily baths, and of the kidneys by diuretic waters. A daily bowel movement should be secured. The diet is to be plain and is to contain a minimum of nitrogen. If syphilis has existed, occasional courses of iodid of potassium are to be given. If the arterial tension at any time becomes inordinately high, administer nitroglycerin. One danger to which the patient is liable is apoplexy; hence excitement and violent exercise are to be avoided. Another danger is senile gangrene; hence the patient should wear woolen stockings, put a bottle or bag of warm water to his feet at night, and be careful to avoid injuring his toes or feet especially when cutting his corns. A bag of very warm water is dangerous and may actually excite gangrene. When a patient with atheroma has dyspnea and is of a livid color, or when the arterial tension is very high, a moderate bloodletting (sixteen to eighteen ounces) does good, and may prevent or arrest edema of the lungs. Still another danger is aneurysm, which may appear suddenly from rupture or gradually from progressive distention.

Treatment of Endarteritis.—It has recently been suggested that endarteritis threatening gangrene should be treated by an anastomosis between the common femoral artery and the femoral vein, in order that the blood may be directed from blocked to open channels, and hence may still nourish the extremity. The operation is only to be advised when pulsation is absent in the tibials, when the femoral high up seems normal, and when the deep veins are patent.

Buerger suggests the following test of the patency of the deep veins ("Jour, Amer. Med. Assoc.," April 24, 1909): "I allow the limb to hang, watch for the advent of the erythema, and wait until a fair degree of cyanosis has become established. This may take considerable time—five to ten minutes.

The veins are then obliterated above the knee by means of a Martin bandage properly applied. The limb is then raised high and the bandage loosened just enough so as to remove pressure from the deep, but not from the superficial veins. If the cyanosis is slow in disappearing or fails to disappear, it may be concluded that the function of the deep veins is impaired."

The operation of arteriovenous anastomosis has been performed at least four times for obliterative endarteritis, viz., by Lilienthal in 1907 (death in thirty hours); by Wieting in 1908 (intubation of the femoral artery below the profunda into the femoral vein below the saphenous; a success); Wieting's second case (anastomosis between the popliteals; failure because of thrombo-

sis); Lurel in 1908 (temporary improvement).

Aneurysm.—An aneurysm is a pulsating sac containing blood and communicating with the cavity of an artery, and formed partly or entirely by the arterial walls or a fusiform dilatation of an artery. Some restrict the term "true aneurysm" to a condition of dilatation involving all the coats of the vessel. We shall consider, with Heath, a true aneurysm to be one in which the blood is included in one or more of the arterial coats, and a false aneurysm to be a condition in which the vessel has ruptured or has atrophied and the aneurysmal wall is formed by a condensation of the perivascular tissues.

Forms of Aneurysm.—The following forms of aneurysm are recognized:

- 1. True aneurysm—one whose sac is formed of one or more arterial coats.
- False aneurysm—one whose sac is formed of condensed perivascular tissues and contains no arterial coat.
- 3. Traumatic diffuse aneurysm—a false aneurysm due to a wound or traumatic rupture of a blood-vessel. At first the blood is widely diffused and unlimited by any sac or capsule, later a limitation or encapsulation may occur by the condensation of tissue, any wound being healed. A traumatic diffuse aneurysm may follow a puncture or an incised wound of an artery, the injury causing the aneurysm directly. It may follow an effort or a strain, the injury indirectly causing the aneurysm by acting on a diseased vessel. As Barwell says, the term traumatic diffuse aneurysm is an extremely bad one, as the term aneurysm conveys the idea of some sort of a sac. In this condition there is no true sac and blood is either unlimited or limited only by condensed tissue.
- 4. Diffused aneurysm—a term used to mean a ruptured aneurysm, the blood being diffused in the tissues and either unlimited or limited only by condensed tissues. The term should be limited to conditions in which the effusion of blood is slow and trivial. If the effusion is large and rapid the term ruptured aneurysm is preferable.
- 5. Consecutive aneurysm—results from the rapid growth of a sacculated aneurysm. At a certain portion of the sac of a true aneurysm the arterial coats give way completely and at this point blood is limited only by clot and by condensed perivascular tissue. The blood is not diffused but is encapsuled, partly by the old sac, partly by condensed tissues, aided it may be by bone and fascia.
- 6. Fusiform or tubulated aneurysm—a variety of true aneurysm, the sac being spindle-shaped and formed, as Matas states, "at the expense of the artery," the artery dilates, the continuity of the parent artery is interrupted

for a variable length, and is lost in the sac, to be restored once more as a normal vessel at the outlet of the aneurysm ("Transactions of Am. Surg. Assoc.," 1905). Such an aneurysm has, of course, two openings. This form, according to Matas, comprises 66.6 per cent. of all aneurysms.

- 7. Sacculated aneurysm-a common form of aneurysm, in which the dilatation is like a pouch, arising from a part of the arterial circumference and joining the lumen of the vessel by a single aperture. As Matas points out, the parent artery is involved in but a portion of its circumference, the continuity of the vessel is not lost, the arterial caliber is maintained at a nearly normal diameter, and "the sac is simply grafted or attached to the artery by a narrow neck, forming a sort of diverticulum of variable shape and dimensions" ("Proceedings of Am. Surg. Assoc.," 1905). Such a sac has but one orifice. The opening from the artery into the sac is called the mouth; around and just above the mouth is the neck; the balance of the sac is much larger than the neck and is called the body. A sacculated aneurysm may arise from an artery of normal size, from a dilated artery or from a fusiform aneurysm. A sacculated aneurysm of unknown cause is called a spontaneous aneurysm; one which is due to injury is called a traumatic aneurysm. The first step in the formation of a sacculated aneurysm is stretching or giving way of an area of the middle coat (media), followed by a gradually advancing stretching and dilatation of corresponding areas of the outer coat (adventitia) and the inner coat (intima).
- 8. Dissecting aneurysm (Shekelton's aneurysm)—a pouch-like dilatation of an artery due to the blood which has gained access to the middle coat through an atheromatous ulcer or a minute rupture of the inner coat. It used to be taught that the blood flows between the media and adventitia; we now know that it flows between the layers of the middle coat. The outer wall of the aneurysm consists of adventitia and a portion of the middle coat. It may or may not join the lumen of the artery at another point by a fresh aperture in the intima. Dissecting aneurysm is practically only met with in the aorta. It is most common in the thoracic aorta. About eighty cases have been reported.\*
- 9. Arteriovenous aneurysm, which is divided into aneurysmal varix, or Pott's aneurysm, where there is direct communication between a vein and an artery; and varicose aneurysm, where there is communication between an artery and a vein by means of an interposed sac.
- 10. Acute aneurysm—a cavity in the walls of the heart, which cavity communicates with the interior of this organ, and which is due to suppuration in the course of acute endocarditis or myocarditis.
  - 11. Aneurysm by anastomosis (see Angiomata).
- Aneurysm of bone—an inaccurate clinical term used to designate a pulsatile tumor of bone.
- Circumscribed aneurysm—when the blood is circumscribed by distinct walls.
- 14. Cirsoid aneurysm—a mass of dilated and elongated arteries shaped like varicose veins and pulsating with each heart-beat.
- 15. Cylindrical aneurysm—a dilatation which maintains the same dimensions for a considerable space.

<sup>\*</sup>Coleman, in Dublin Jour. Med. Sciences, Aug., 1898

- 16. Embolic or capillary aneurysm—dilatation of terminal arteries due to emboli.
  - 17. Spontaneous aneurysm-non-traumatic in origin.
  - 18, Miliary aneurysm—a minute dilatation of an arteriole.
- 19. Secondary aneurysm—one which, after apparent cure, again pulsates, the blood entering by means of the anastomotic circulation.

20. Verminous aneurysm—one containing a parasite. This form of aneurysm is met with in the mesenteric artery of the horse.

The sac of a sacculated aneurysm is at first composed of at least two of the arterial coats, reinforced by the sheath and perivascular tissues. After a time the blood-pressure distends the sac, and the inner and middle coats either stretch with interstitial growth or—what is more common—are worn away and lost. When all the coats are lost, and the blood is sustained only by the sheath and surrounding tissue, a true aneurysm becomes a false or consecutive aneurysm, the limiting tissues and sheath being condensed, thickened, and glued together. This limiting process is deficient in the brain; hence cerebral aneurysms break soon after their formation. When all the arterial coats are lost, the blood-pressure, acting on the tissues, finds some spots less resistant than others, the blood follows the lines of least resistance, the aneurysm grows with great rapidity, and soon ruptures externally or into a cavity.

An aneurysm may rupture into a cavity (pleural, pericardial, or peritoneal), into the perivascular tissues, or through the skin. Rupture into the tissues may produce pressure-gangrene. When rupture occurs through the skin the hemorrhage is not often instantly fatal, but during several days recurs again and again in larger and larger amounts. The pressure of an aneurysm causes atrophy of tissues, hard and soft, bones and cartilages being as easily destroyed as muscles and fat. Sometimes the perivascular tissues inflame and suppurate, and the sac is opened rapidly by sloughing. An aneurysm usually progresses toward rupture, the slowest in this progression being the fusiform dilatation, which may exist for many years, but which finally is converted into the sacculated variety.

In some rare instances there takes place spontaneous cure, which may result from laminated fibrin being deposited upon the walls of the sac as the blood circulates through it. This laminated fibrin is known as an "active clot," and eventually fills the sac. The weaker and slower the blood-stream, the greater is the tendency to the formation of an active clot; hence any agent impeding, but not abolishing, the circulation aids in the deposition. This weakening and slowing of circulation may be brought about by great activity of the collateral circulation diverting most of the blood from the area of disease. Sometimes a clot breaks off from the sac-wall and plugs the artery beyond the aneurysm, and the anastomotic vessels, enlarging, divert the blood-stream. A large aneurysm, falling over by its own weight upon the vessel above the mouth of the sac, may, in very unusual cases, diminish the blood-stream. The development of another aneurysm upon the same vessel nearer to the heart weakens the circulation in and may cure the older one. Inflammation occasionally forms a clot. The tissues about an aneurysm tend to contract when arterial force is lessened; hence tissue-pressure may more than counteract blood-pressure when the circulation is feeble. Clotting of the blood contained within a sac, circulation through the aneurysm having ceased, causes a "passive clot." A passive clot, which occasionally induces cure, may arise from a twist of the neck of the sac preventing the passage of blood; from the lodgment of a clot in the mouth of the sac; and from inflammation. Spontaneous cure is, unfortunately, very rare.

Causes of Aneurysm.—Gradual distention of arterial coats which are in a condition of arterial sclerosis, or of coats whose resisting power is lowered because of atheroma, may cause aneurysm. Hence the causes of sclerosis and atheroma are also causes of aneurysm. The principal cause of aneurysm is increased blood-pressure. This increase may be brought about by severe labor; by sudden strains, as in lifting; by violent efforts, as in rowing in a boat-race; by chronic interstitial nephritis; by hypertrophy of the heart; by alcoholic excess; and by syphilis. Arterial disease is commonest in the larger vessels, and in the aged, but it may occur in youth. When an aneurysm follows a strain, it may be due to laceration of the media and loss of resistance at a narrow point. The intima may lacerate, permitting the blood to come in contact with the media or causing blood to diffuse between the coats (dissecting aneurysm). When an embolus lodges in an artery the vessels may become aneurysmal on the proximal side of the clot. The embolus, if infective, causes softening, and if calcareous causes laceration (Osler). Colonies of micrococci may cause aneurysm.\* The parasite strongylus armatus causes aneurysm of the mesenteric arteries in horses. Suppuration around a vessel weakens its coats and tends to aneurysm by inducing acute arteritis and softening. Sometimes an individual develops multiple aneurysms the origins of which are absolutely unknown. A bruise of a vessel may be followed by aneurysm. A cut or puncture of a healthy artery may lead, after the surface wound heals, to the development of an aneurysm. Such an aneurysm does not differ in symptoms or treatment from the other form.

The constituent parts of an aneurysm are (1) the wall of the sac; (2) the cavity; (3) the mouth; and (4) the contents.

Symptoms of Aneurysm.—The formation of an aneurysm, when sudden, is occasionally, though rarely, appreciated by the patient, and is described by him as a feeling of something having given way. In most instances the feeling of beating and the discovery of the lump are the first intimations that anything is wrong. An oval or globular, soft, elastic, and pulsatile protrusion develops in the line of an artery. It is usually quite evident to the touch that the sac contains fluid, but sometimes in old aneurysms the sac feels firm or even hard, because of the deposit of fibrin upon its inner surface. In a partially consolidated aneurysm pulsation may be slight or even inappreciable. The protrusion instantly ceases to pulsate and almost disappears on making firm pressure on the artery above. On relaxing the pressure the pulsatile enlargement at once reappears. Direct pressure upon the tumor may cause it to almost disappear. Pressure upon the artery below causes the tumor to enlarge. The pulsation is expansile-that is, the sac expands in all directions during every cardiac contraction-and if an index-finger be laid on each side of the tumor so that the points nearly touch, each pulsation not only lifts the fingers but it also separates them. It is important to remember that a large intrathoracic aneurysm which is in contact with the chest may not exhibit

expansive pulsation, but simply transmit pulsation from the blood-stream (Sidney Lange, in "N. Y. Med. Jour.," Nov. 21, 1908). On placing a stethoscope over the aneurysm or over the vessel below the aneurysm there is imparted to the ear a distinct bruit which travels in the direction of the bloodstream, is systolic in time, and is usually blowing in character. In some cases bruit is absent (when a sacculated aneurysm has a very small mouth, when the circulation is tranquil, or when the sac is full of blood and clot). When bruit is absent, it may sometimes be developed by muscular exercise or raising the affected limb (Halloway). In rare cases there may be a double bruit. Occasionally in fusiform aortic aneurysm linked with aortic regurgitation a diastolic bruit exists. A bruit is arrested by pressing upon the artery between the aneurysm and the heart. A patient who has an aneurysm of an extremity complains of a sensation of beating, of weakness or stiffness of the limb, frequently of pain in a nerve, a feeling of fatigue in the muscles, and edema and dilated veins are apt to develop because of pressure upon large veins and loss of vis a tergo in the circulation. The skin over an aneurysm may be normal, may be discolored, may ulcerate, or even slough. The pulse below an aneurysm is weaker than the pulse of a corresponding part of the opposite limb. This is well shown by sphygmographic tracings (Fig. 170). The tracings taken below





Fig. 170.—Radial pulse-tracings in aneurysm of right brachial artery: 1, Left radial pulse; 2, right radial pulse (after Mahomed).

an aneurysm are rounded without a sudden rise or an abrupt fall. In internal aneurysms pressure-symptoms are marked. Thoracic aneurysm causes intercostal pain; iliac aneurysm causes pain in the thigh. Aneurysm of the thoracic aorta pressing upon the pneumogastric nerve causes spasmodic dyspnea, and upon the recurrent laryngeal, causes hoarseness, which may be associated with loss of voice, cough, and laryngeal spasm, and is due to unilateral abductor paralysis. Pressure upon a bronchus or the trachea causes dyspnea from obstruction, dysphagia, and cough from laryngeal spasm. Pressure upon the cervical sympathetic first causes dilatation and later contraction of the pupil of the same side. An aneurysm in the neck may interfere with the cerebral circulation and produce vertigo and even attacks of unconsciousness. The evidences of rupture of an aneurysm of an extremity into the tissues are loss of distinctness of outline and increase in area of the tumor, weakening or disappearance of both bruit and pulsation, absence of pulse below the aneurysm, severe pain, edema and coldness of the surface, shock, and possibly syncope. External hemorrhage may arise; the tissues may become extensively infiltrated with blood; sloughing or gangrene may ensue. Death is frequent, and only in very rare cases does

spontaneous cure take place. Rupture of a large aneurysm into a cavity causes intense pallor, advancing weakness, syncope, and death.

Diagnosis.—A cyst or abscess over a vessel may show transmitted pulsation which is not expansile, and the tumor does not disappear when pressure is made upon the vessel above it. The pulsation ceases when the growth is lifted off the vessel, or when the position is changed so as to permit it to fall away from the vessel. There is no true bruit, and the history is widely different. A growth under a vessel may lift the vessel and simulate an aneurysm, but the pulsation is not noted in the entire growth, the growth does not disappear on proximal pressure, and there is only a false, and never a true, bruit. The larger the growth under a vessel, the less is the pulsation, because of pressure narrowing the caliber of the vessel. A sarcoma, especially a soft sarcoma attached to the bone, and also a nevoid mass, pulsate and often have a bruit; the tumor never disappears from proximal pressure, though it may slowly diminish in size, to gradually enlarge again when pressure is withdrawn. These growths do not feel fluid, and are rarely circumscribed. An aneurysm may cease to pulsate from consolidation leading to cure, or from rupture. Rupture of a large aneurysm into a cavity induces deadly pallor, syncope, and rapid death. Rupture of an aneurysm of an extremity into the tissues is made manifest by a sensation of something breaking, by pain, by sudden increase in size, by diminution or absence of bruit and pulsation, by absence of pulse below the aneurysm, by swelling and coldness of the limb, and by shock.

Treatment.—(For the history of the evolution of the treatment of aneurysm. see "Studies in Aneurysm," by James G. Mumford, "Cleveland Med. Jour.," Feb., 1908.) In inoperable aneurysms, general, medical, and dietetic treatment must be tried. A chief element in treatment is rest in bed to diminish the rapidity and force of the circulation and favor fibrinous deposit. Valsalva long ago suggested rest, occasional bleeding, and a diet just above the point of starvation. Tuffnell's plan is to reduce the heart-beats by rest and mental quiet, and to rigidly restrict the diet so as to diminish the total amount of blood and render it more fibrinous. Liquids are restricted in amount, and the patient lives through each twenty-four hours upon 4 ounces of bread, a very little butter, 8 ounces of milk, and 3 ounces of meat. This plan is pursued for several months if possible, or it is employed for several weeks, intermitted for a short period, the rigid diet again returned to, and so on, over and over again. There can be no doubt that Tuffnell's treatment sometimes cures aneurysm by decidedly lowering the blood-pressure. Many who suffer from aneurysm may be permitted to go about, taking their time about everything and avoiding work, worry, and excitement. The diet should be low and nonstimulating, and the bowels must be maintained in a loose condition.

Even in an operable case diet and rest are of importance. The patient should remain in bed for a number of days before operation, the daily diet consisting of ten or twelve ounces of solid food with a pint of milk. If the circulation is very active, use aconite and allay pain by morphin.

Iodid of potassium in doses of 20 grains undoubtedly does good in aneurysm and not only in syphilitic cases. It seems to lower the blood-pressure. Balfour taught that it thickened the walls of the sac. Osler says it relieves the pain. Iron, acetate of lead, and ergotin are prescribed by some. Digitalis

is contraindicated, as it raises the blood-pressure. S. Solis Cohen has used with some success the hydrated chlorid of calcium. Morphin and bromid of potassium are occasionally useful to tranquilize the circulation, allay pain, or secure sleep. Aconite and veratrum viride have long been employed.

Lancereaux and others claim that hypodermatic injections of gelatin at some indifferent point may cure aortic and subclavian aneurysm. In 1896 Dastres and Floresco proved that gelatin injected in the blood increases coagulability. Later Lancereaux and Paulesco showed that injections into the subcutaneous tissue act similarly. Carnot pointed out that gelatin applied to a wound may arrest bleeding. How gelatin acts is uncertain, but that it does increase blood-coagulability seems proved. The value of injections of gelatin for aneurysm is in dispute. Lancereaux warmly advocates its use for sacculated aneurysm and says that after the first dose the aneurysm is seen to shrink and the pulsation is observed to lessen. He injects it slowly and with aseptic care into the subcutaneous tissue of the thigh, using normal salt solution containing from 5 to 10 per cent, gelatin. He never injects less than 5 gm. He gives an injection every tenth to fifteenth day and administers from ten to twenty injections. But the treatment is not free from danger; several deaths have taken place, and several persons have died from tetanus. Care must be taken not to inject gelatin into a vessel, and it must never be thrown about the aneurysmal sac. It irritates the kidneys and its use is contraindicated in renal disease. The injections cause much pain, and it is very doubtful if they do any real good in aneurysm. If used, it should be given at the temperature of the body, and not over 3 gm. should be administered at one dose. A 10 per cent, solution is the proper strength and from 10 to 20 c.c. the correct dose. Gelatin can be given by the mouth. When thus given it is not so powerful, but its coagulating property is not destroyed by digestion. Gelatin in normal salt solution is known as Carnot's solution. Carnot's solution is best prepared by Sailer's formula, as follows (Joseph Sailer, in "Therapeutic Gazette," August, 1901): Take 5 gm. of common salt, 1 liter of distilled water, and 100 gm. of gelatin. Bring the water to a temperature of 80° C. and slowly stir in the gelatin until it is all in solution. Remove the solution from the stove, cool it to 40° C., add to it the white of one egg, and stir for several minutes, and then put the flask on the stove and boil the fluid. The white of egg coagulates and clears the solution. Filter through gauze and then through paper. Place the fluid in test-tubes, each of which will contain 10 c.c., and insert a cotton plug in the mouth of each tube. Sterilize by putting the tubes in a steam sterilizer for fifteen minutes on three successive days. When we wish to use a tube, place it in a cup of hot water until the gelatin liquefies, pour the gelatin into a sterile glass, and draw it up into a sterile syringe. When kept several weeks the tubes dry out.

Other expedients sometimes used in the treatment of aneurysm are: the kneading of the sac to release a clot, in the hope that it will plug the mouth of the sac or the artery beyond it—this is dangerous; electricity; electrolysis; the injection of an astringent liquid; the insertion of a fine aspirating needle and the pushing through it into the sac of a large quantity of silver wire, in the hope that it will aid in whipping out fibrin. Some physicians have inserted needles and horsehair.

Treatment by Pressure.—Instrumental pressure is made by applying two Signorini tourniquets or some specially devised apparatus to limit the flow of blood through an aneurysm without entirely stopping it, the aneurysmal sac being felt to still slightly pulsate. In some situations Lister's abdominal tourniquet is applied; in other regions we may use Tuffnell's compress, which is like a spring truss and is strapped in place. A heavy body suspended over the artery and resting part of its weight upon the vessel has occasionally brought about cure. Compressing instruments can be worn for from twelve to sixteen hours at a time; usually they are removed to permit sleep and are reapplied the next day, and so on for several days. Before applying the compress be sure the sac is full of blood, and render this certain by applying for a few minutes distal compression. This method may cure, but it is very painful. It cannot be used successfully in treating aneurysm of the axillary, subclavian, or carotid artery. It aids in the formation of an active clot.

Digital pressure, made with the thumb aided by a weight, and maintained for many hours by a relay of assistants, has cured many cases. This method may be used alone or may be used as an accessory to instrumental pressure. Its chief field is in the treatment of aneurysm for which other methods are inapplicable (orbit and root of neck). It entirely cuts off the blood and promotes the formation of a passive clot. If cure does not take place in three days, abandon pressure. It must often be abandoned far earlier because of pain.

Direct pressure upon the sac has been used in aneurysm of the popliteal artery, the pressure being obtained by flexing the leg; and in aneurysm of the brachial artery pressure has been applied at the bend of the elbow by flexing the elbow. The pressure of a hollow rubber ball has been used in aneurysm of the subclavian.

Rapid pressure completely arrests the passage of blood through the sac for a limited time, and is applied while the patient is under the influence of an anesthetic. Take, for example, a case of popliteal aneurysm: the patient is placed under the influence of ether; two Esmarch bandages are used, one being applied to the limb from the toes up to the lower limit of the aneurysm, and the other from the groin down to the upper limit of the sac, and the Esmarch band is fastened above the upper bandage. This procedure stagnates the blood both in the veins and in the arteries, and the sac remains full of blood. Pressure is thus maintained for three or four hours, and on removing the Esmarch apparatus a tourniquet is put on the artery above the aneurysm and partly tightened in order to limit the amount of blood passing through and thus prevent the washing away of clot. This method of rapid pressure sometimes cures by forming a passive clot, but it sometimes results in gangrene. It was devised by John Reid.

Operative Treatment: By the Ligature and by Sutures.—Ligation of the main artery was the operation employed by most surgeons until the Matas operation was introduced. The methods of ligation are: (1) the method of Antyllus; (2) extirpation of the sac; (3) the method of Anel; (4) the method of Hunter;

(5) the method of Wardrop; and (6) the method of Brasdor.

The method of Antyllus (Fig. 171), a Roman successor to Galen, who lived in the third century, A. D., is usually described as a method involving a direct attack upon the sac itself. The artery is ligated immediately above and

below the sac, the sac is opened and its contents turned out, or the sac is extirpated. As a matter of fact, Antyllus advocated applying a ligature on each side of the sac and opening the sac in order to evacuate its contents, but he distinctly opposed extirpation because of its danger. All we know of Antyllus is found in the writings of Oribasius, who lived in the fourth century. Syme maintained many years ago that incision of the sac is the proper operation for aneurysm of the gluteal, iliac, carotid, and axillary arteries, but Syme's method is productive of fearful hemorrhage and the plan of Antyllus is vastly better. Syme opened the sac, inserted his finger, and plugged the artery toward the heart until a ligature was applied and tied. He then packed the sac with lint.

Extirpation of the sac, if practised, should be carried out after applying a ligature on each side, after the method of Antyllus. It was originally practised by Philagrius and was reintroduced by Purmann in 1699 (Moynihan, in "Annals of Surgery," July, 1898).

Extirpation finds warm advocates in Delbet, Littlewood, and Moynihan. Moynihan claims that, as compared with distal ligature, there is a greater chance of recovery, no chance of recurrence, less risk of gangrene, and complete recovery from troubles due to nerve interference ("Annals of Surgery," July, 1898). Extirpation is regarded by some surgeons as the best operation



Fig. 171.—Old operation of Antyllus for aneurysm ("Am. Text-Book of Surgery").



Fig. 172.—Anel's operation for aneurysm ("Am. Text-Book of Surgery").

for traumatic aneurysm, but if the vessel is seriously diseased near the sac some other method should certainly be employed. In aneurysm of the common carotid after extirpation (as after ligation) there is grave risk of cerebral embolism, and it will be wise to attempt a re-establishment of the circulation by circular suture of the two ends, or, as Lexer did in the axillary artery, autoplasty with a piece of the internal saphenous vein. In the extremities there is much less danger of gangrene after Matas's operation than after extirpation.

The Method of Anel.—Anel, of Turin, devised and performed this operation in 1710. In Anel's method the artery is ligated above the sac, and so close to it that there are no anastomotic branches between the sac and the ligature (Fig. 172). It is used only for traumatic aneurysms, and is never employed when the vessel is diseased beyond the aneurysm. Either extirpation or Matas's operation is preferable to Anel's operation.

The Method of Hunter.—This operation, which is the modern method of ligation, was devised by the illustrious John Hunter and was first employed by him in January, 1786. He is said by Sir Everard Home to have recognized the fact that the vessel adjacent to an aneurysm was apt to be diseased, and he discovered the anastomotic circulation. Putting together these two facts, he devised the operation which goes by his name. It consists in applying a

ligature between the heart and the aneurysm, but so far above the sac that collateral branches are given off between it and the point of ligation (Fig. 173). This operation, which is done upon a healthy portion of the artery, does not permanently cut off all blood, but so diminishes the force and frequency of the circulation that an active clot forms within the sac. Thus are lessened the dangers of secondary hemorrhage and gangrene. According to Stimson ("New York Med. Jour.," July, 1884), Hunter really builded better than he knew, for he sought only to tie the artery without opening the sac and at a healthy point, but said not a word about the necessity of having branches between the sac and the ligature or about the desirability of diminishing the flow of blood instead of cutting it off completely (Moynihan, in "Annals of Surgery," July, 1898). Hunter tied the artery in the region now known as Hunter's canal. Scarpa introduced the custom, which we still follow, of tying it in Scarpa's triangle. The Hunterian method was for many years regarded by most surgeons as the proper operation for aneurysm in the majority of cases. In some cases pulsation does not return after tightening the ligature; in most cases, however, it reappears for a time after about thirty-six

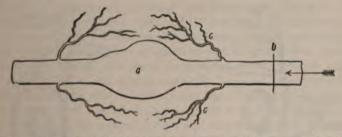


Fig. 173.—Hunter's method of ligating for aneurysm: a, The aneurysm; b, point of ligation; ε, the branches between the aneurysm and the ligature. The arrow shows the direction of the blood-current.

hours, but is weak from the start, constantly diminishes, and finally disappears permanently. Previous prolonged compression by enlarging the collateral branches permits strong pulsation to recur soon after ligation, and thus militates against cure; hence it is a bad plan to use pressure in cases admitting of ligation, and in which the success of pressure is very doubtful. Occasionally after Hunter's operation the sac suppurates, producing symptoms like those of abscess. Suppuration may occur between the first and the thirty-second week after ligation.\* When pus forms, open freely, as we would open an abscess, and if no blood flows, treat as an abscess, but have a tourniquet loosely applied for several days ready to screw up at the first sign of danger. If hemorrhage occurs, tie the vessel above and below the aneurysm, open the sac, and pack with iodoform gauze. If bleeding recurs, there is no use reapplying the ligature and there is little use tying higher up. If dealing with an arm, try the application of a ligature higher up; if dealing with a leg, amputate at once.

Distal Ligation.—When an aneurysm is so near the trunk that Hunter's operation is impracticable, or when the artery on the cardiac side of the

<sup>\*</sup> See the case described by Sir Astley Cooper.

tumor is greatly diseased, distal ligation may be employed. Distal ligation forms a barrier to the onflow of blood, collateral branches above the aneurysm enlarge, the blood-current is gradually diverted, and a clot may form within the aneurysm. Distal ligation is used in some aneurysms of the aorta, iliacs, innominate, carotids, and subclavians. It occasionally causes rupture of the sac of the aneurysm. I have obtained two notably successful results in aneurysms of the innominate artery by ligation of the common carotid and subclavian of the right side. In each of these cases I tied both vessels at one séance, tying the carotid first. In one case I tied the third part of the subclavian and in the other the first part.

The operation of Brasdor consists in tying the main trunk some little distance below the aneurysm (Fig. 174). It completely arrests circulation in the sac. The operation was introduced in 1760 by the French surgeon

Brasdor.

The operation of Wardrop consists in tying one of the branches of the artery below the aneurysm. Wardrop originally advocated ligation at a point where there is no intervening branch between the sac and the ligature.



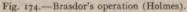




Fig. 175.-Wardrop's operation (Holmes).

Later he advocated ligation at a point where there is an intervening branch. Since then it is the custom to consider Wardrop's operation to be the ligation of one branch below the aneurysm, as shown in Fig. 175. The circulation is but partially arrested by Wardrop's operation. The operation was introduced in 1825. An x-ray picture should be taken in every case of aortic aneurysm. Such a picture may aid us in coming to a conclusion as to which vessel or vessels to tie.

Matas's Operation (Aneurysmorrhaphy).—This procedure was first practised by Matas in 1889 on a negro suffering from traumatic aneurysm of the brachial artery in the middle of the arm. The operation was a complete success. In 1900 he began again to use this method, and in 1902 described it to the profession ("Transactions of Am. Surg. Assoc.," 1902; "Annals of Surg.," Feb., 1903; "Transactions of Am. Surg. Assoc.," 1905).

One procedure, applicable to ordinary fusiform aneurysms, is called obliterative endo-aneurysmorrhaphy without arterioplasty (Fig. 176). "No attempt is made to reconstruct the parent artery (arterioplasty), and the arterial orifices are simply obliterated by suture." By sutures applied within the

incised sac, the sac is cut off from the circulation without disturbing adjacent collaterals and without interfering with the nutrition of the sac walls. After this operation there is very seldom secondary hemorrhage, gangrene, or relapse.

A modification of the above operation applied to sacculated aneurysms in which there is one orifice of communication with the artery is called endoaneurysmorrhaphy with partial arterioplasty (Fig. 176). The sac is opened, clots are washed away, the opening of the aneurysm into the artery is closed by a continuous suture passing through all the coats of the sac at the edge of the opening into the artery. Blood is thus excluded from the sac, the lumen of the artery is not, however, obliterated, and the blood-supply of parts beyond is not interfered with. After closing the cut in the arterial wall the sac is obliterated by rows of sutures inserted in its walls. Matas reports 4 cases operated upon successfully by this plan. In a fusiform aneurysm with a firm and resisting sac wall, and in which there are two openings near together on the floor of the sac, endo-aneurysmorrhaphy with complete arterioplasty may be performed (Fig. 176). This operation restores arterial continuity, a new ' channel being made out of the sac walls "by simply holding these over a rubber guide (tube or catheter) and suturing them firmly together so as to restore the continuity of the artery lost in the sac." The catheter is withdrawn before the final sutures are tied. This operation has been performed successfully by Morris and also by Craig. Some surgeons are fearful that such an operation will be followed by relapse, and one of the reported cases did relapse. Matas says that preservation of the arterial lumen is "only indicated positively in the sacciform aneurysms with a single opening where the parent artery already exists as a formed vessel and in which the closure of the fistulous opening can be accomplished with the greatest facility and simplicity" (address delivered at the Medical Assoc. of Alabama, April 22, 1906). It is not probable that the artery remains patent long, because the seat of aneurysm is a diseased vessel and vascular disease will probably cause clotting, but even a temporary restoration of circulation if followed by gradual abolition prevents gangrene. The Matas operation differs notably from the Antyllus operation in the fact that it saves certain collaterals which the Antyllus method destroys, and the retention of these collaterals may prevent gangrene in the limb. It differs from it further in the fact that it occludes certain small vessels which after the Antyllus method continue to convey blood into the sac. It is superior to extirpation because it does not destroy the vascular walls of the sac, the bloodvessels of which, if unblocked, aid in preventing gangrene.

Matas points out that suture of an aneurysm is indicated only when certain essentials exist.

r. The situation of the aneurysm must admit of the control of the circulation temporarily on the proximal side of the sac. In most aneurysms of the extremities this is done by the elastic band of Esmarch. In the neck and abdomen both the cardiac and peripheral sides of the main vessels must be secured by traction loops and compression.

 The sac must be freely opened in a longitudinal direction. Its wall must not be dissected and must be separated as little as possible from surrounding tissue.

3. Every orifice opening into the sac must be thoroughly exposed so that

they can be closed by sutures. The suture material is chromic gut, the num-

ber being 1, 2, or 3, according to the size of the aneurysm.

Fig. 176, A to H, shows Matas's various operations. For a full description of them see the previously quoted articles of the author. I believe that the Matas operation is a very notable advance in surgery, that it is the most important work that has been done in aneurysm since the studies of John Hunter, that it is safer than older methods, and much less apt to be followed by gangrene. The idea seems to be general that Matas always seeks to restore arterial lumen. This is not the case. He only seeks to do this in exceptional cases. The essence of his method is to cure the aneurysm by sutures within the sac and by obliteration of the sac. I have performed the Matas operation (obliterative endo-aneurysmorrhaphy) successfully on a case of ruptured fusiform popliteal aneurysm and on a case of ruptured sacculated popliteal aneurysm. In the latter case there was profuse hemorrhage during the operation from vessels opening into the sac.

Matas, in "Jour. Am. Med. Assoc.," Nov. 14, 1908, has collected 85 cases (excluding arteriovenous aneurysm).

## VESSEL INVOLVED.

Abdominal aorta 2	Posterior tibial
External iliac, I	External carotid
Gluteal 1	Subclavian 1
Iliofemoral 5	Subclavio-axillary 2
Femoral, 18	Axillary 1
Popliteal 50	Brachial 2

There were 78 recoveries, 2 cases of secondary hemorrhage, 4 cases of gangrene, and 4 relapses (all of them after reconstructive operations).

Halsted's Method by Partial, Progressive, and, finally, Complete Occlusion by Metal Band.—This method is applied only to the aorta and other very large arteries. A number of surgeons have sought a method to gradually and safely occlude the abdominal aorta in order that they may attempt to cure aneurysm of the aorta or of the iliac arteries. The usual thought was to leave a metal instrument fixed to the aorta, the handle projecting from the abdominal wound, and a metal clamp or a snare of silk or catgut being around the vessel, so that, by means of a screw arrangement, pressure could be gradually increased.

Halsted showed that by this plan sepsis almost certainly occurs along the track of the instrument (see W. S. Halsted, in "Johns Hopkins Bulletin," 1905, xvi, 346; "Jour. Am. Med. Assoc.," 1906, xlvii; "Jour. Experimental Medicine," vol. xi, No. 2, 1909). Halsted sought for a method "permitting, in each entre-act, complete closure of the wound." He uses a band of aluminium curled in cylinder form about the vessel. This material admits of easy readjustment at a future operation, and it is tightened with the fingers.

Halsted's band, when used to partially occlude, seldom causes macroscopic alteration in the wall of the vessel; when used to completely occlude, the vessel may undergo atrophy. Ideal closure is when the lumen was nearly but not quite occluded, spontaneous obliteration having arisen, the arterial wall embraced by the band having undergone conversion into "a solid cylinder of living tissue."

Halsted has made numerous experiments on dogs and has used the band

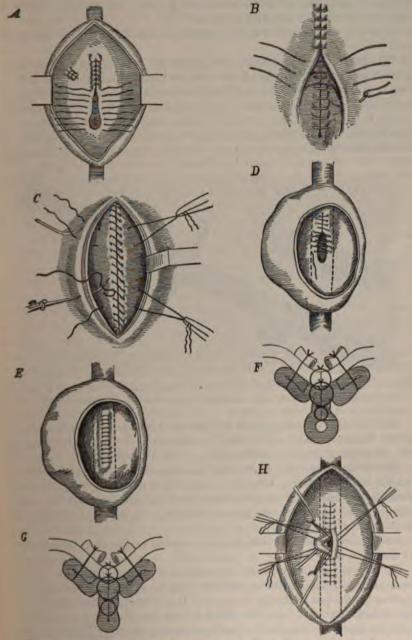


Fig. 176.—The radical cure of aneurysm based upon arteriorrhaphy (Matas): A, First tier of sutures in a fusiform aneurysm; B, second tier of sutures, some of which are tied; C, sutures to approximate the walls of the aneurysm; D, suturing the opening in a sacculated aneurysm—the main artery is not obliterated; E, opening completely closed; F, diagram of cross-section of parts after complete obliteration of sac but with restoration of blood-channel; G, diagram of cross-section of para after complete obliteration of sac and blood-vessel; H, operation for fusiform aneurysm when we wish to restore the blood-channel—sutures applied over a rubber tube, most of the sutures ided, tube withdrawn, and remaining sutures tied.

with encouraging results on the human being (partial occlusion of the innominate, twice, common carotid, four times).

In getting the band ready for application it is rolled by means of the instrument shown in Fig. 177.

Treatment After Operation for Aneurysm.—After operating for aneurysm of an extremity by the ligature or by sutures, elevate the limb slightly, keep it warm by wrapping in cotton and surrounding with bags of warm water, and subdue arterial excitement. When gangrene of a limb follows ligation, await a line of demarcation, and when it forms, amputate. Rupture of the sac after ligation may produce gangrene or be associated with suppuration, the first condition demanding amputation, and the second incision for drainage.

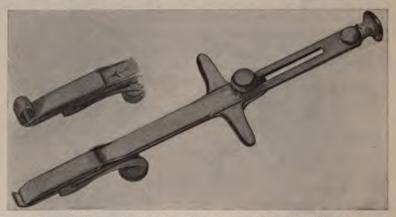


Fig. 177.—Halsted's improved band roller: The instrument shown in full length is unloaded; in the abbreviated cut the band is about to be expelled from the roller (Halsted).

Injection of coagulating agents into the sac (ergot, perchlorid of iron, etc.) is very dangerous and is to be utterly condemned. It may lead to suppuration, gangrene, rupture, or embolism.

Manipulation to break up the clot was suggested by Sir Wm. Fergusson and has been practised. The object aimed at is to have a fragment of clot block up the vessel upon the peripheral side of the artery and act like a distal ligature. The method is dangerous, especially in carotid aneurysm, and should never be employed.

Amputation, instead of distal ligation, is performed in some perilous cases of subclavian aneurysm.

Electrolysis.—An attempt may be made to at once coagulate the blood in the sac, or from time to time an endeavor may be made to produce fibrinous deposits, but the first method is the better. It is, however, seldom possible to at once occlude a sac, and pulsation, which is for a time abolished, usually recurs as the gas present is absorbed. Use the constant current. Take from three to six cells which stand in point of size between those used for the cautery and those used for ordinary medical purposes. A platinum needle is attached to the positive pole and a steel needle to the negative pole, each needle being insulated by vulcanite at the spot where the tissues will touch it. The asepticized needles are plunged into the sac where it is thick, and they are kept near

together. The current is passed for a variable period (from half an hour to an hour and a half). This operation is not dangerous. Pressure stops the bleeding. Electrolysis often ameliorates, and sometimes, though very rarely, cures, aortic aneurysms.\*

Acupuncture consists of the partial introduction of a number of ordinary sewing needles into an aneurysmal sac and leaving them in it for five or six days or more. Professor Macewen introduces a needle, and with it irritates the interior of the sac of an aneurysm, hoping thus to cause deposition of leukocytes and clot-formation.

Introduction of Wire. - Insert into the sac a hypodermatic or small aspirating needle, and push through the needle or cannula a considerable quantity of aseptic gold wire, which is allowed to remain permanently. Electrolysis should be combined with the introduction of wire. This operation was first proposed by Corradi. Loreta and Barwell both inserted wire into an aneurysm before Corradi, but Corradi inserted wire and also used electricity. Corradi's operation can be used when distal ligation cannot be carried out, and can be used even when the vessel is extremely atheromatous. It finds its chief use in aneurysms of the thoracic aorta and innominate. In some cases of abdominal aneurysm the belly has been opened and the operation carried out. The operation has not many elements of danger. There are on record over 60 operations for thoracic aneurysm by this method and 8 for abdominal aneurysm. Some cases have been notably improved. The operation is performed with aseptic care. If the thoracic aorta is to be operated upon, an anesthetic is not required. If the abdominal aorta is to be wired, the patient must be anesthetized, because the abdomen needs to be opened. The wire used must have been previously drawn, so that it will easily pass through a hypodermatic needle and will coil up spirally within the sac. The best wire is of silver or gold. It is a great mistake to introduce a large quantity. Stewart decided that a globular sac 3 inches in diameter requires from 3 to 5 five feet, and a sac 5 inches in diameter requires from 8 to 10 feet. A hypodermatic needle, insulated up to 1 inch of the point, is carried into the interior of the aneurysm through a fairly thick portion of the sac. The shoulder of the needle is not insulated and must not be permitted to touch the skin, because if it did so it would cause a burn by electrolysis. The required amount of wire is introduced. The wire is attached to the positive pole of the battery. The negative pole is fastened to a large flat piece of clay or a pad of moistened absorbent cotton, and the negative electrode is placed upon the back or abdomen. The current is turned on gradually until the necessary strength is obtained (40 to 80 ma.). When ready to terminate the operation the current is lowered gradually to zero, the needle is withrdawn, the wire is cut off close to the skin, the end is pushed under the skin, and the puncture is covered with iodoform collodion. The entire operation requires from threequarters of an hour to one and a half hours. † A clot forms with considerable rapidity and expansile pulsation may lessen or cease. It requires from a number of days to several weeks for the clot to become hard. The operation can be repeated if necessary.

<sup>\*</sup>See John Duncan, in Heath's Dictionary.
†The above description is condensed from that of D. D. Stewart, in "Phila. Med. Jour.," Nov. 12, 1898.

Cure is not obtained. As Hare says, "adjacent tissues of the vessel sooner or later give way, because the effort is like an effort to mend a rotten hose, though mended at one spot it breaks at another. The operation causes promptly notable diminution of pain, an amelioration usually spoken of by the patient before he leaves the operating table. Dyspnea is also benefited and just as rapidly" (H. A. Hare, in "Therapeutic Gazette," April, 1908).

Treatment of Aneurysm Following Wound of a Healthy Artery.— The prognosis in such a case is usually extremely good. The treatment is as for the other forms. Extirpation is particularly adapted to such direct traumatic aneurysms in the neck and Matas's operation to those in the extremities.

Diffuse Traumatic Aneurysm.—When an artery ruptures or an aneurysm ruptures and a large mass of blood is extravasated into the tissues, no complete sac exists, and the condition is usually called diffuse traumatic aneurysm. In diffuse traumatic aneurysm a large oblong, fluctuating swelling is found. If the rent is large, there are bruit and pulsation. There is no pulsation in the artery below the aneurysm, and the limb is cold and swollen. The skin is at first of a natural color, but later becomes thin and purple.

Treatment.—If an aneurysm ruptures, cut down upon the aneurysm, incise the sac longitudinally, and perform Matas's operation. Some surgeons

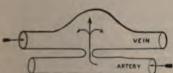


Fig. 178.-Dilatation of veins in arteriovenous aneurysm of the femoral vessels.

cut down to the aneurysm, tie on each side of the tear, open the sac, and pack it (the operation of Antyllus), but Matas's operation is the preferable procedure. If an artery is ruptured, empty the limb of blood, apply an Esmarch band above, and expose the seat of rupture by incision. If possible, suture the opening; if this is not possible, tie the vessel on each side of the rupture and excise the intervening portion. If the main vein is also ruptured, amputate if suture of the vessels is impossible.

Arteriovenous aneurysm was first described by Wm. Hunter in 1757. By this term we mean an unnatural passageway between a vein and an artery, through which passage blood circulates. There are two forms: (a) aneurysmal

varix, or Pott's aneurysm, a vein and an artery directly communicating; and (b) varicose aneurysm, a vein and an artery communicating through an intervening sac. These conditions arise usually from punctured wounds, the instrument passing through one vessel and into the other, blood flowing into the vein, the subsequent inflammation gluing the two vessels together, and the aperture failing to close (aneurysmal varix, Fig. 179). After the infliction of the wound the two vessels may separate; the blood continuing to flow from artery into vein, and the blood-pressure, by consolidating tissue, forming a sac of junction (varicose aneurysm, Fig. 180). Wounds produced by small bullets may result in arteriovenous aneurysm (Matas, in "Transactions of Am. Surg. Assoc.," vol. xix). Aneurysmal varix is a less grave disorder than varicose aneurysm. Arteriovenous aneurysm used to be most frequent at the



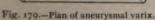




Fig. 180.-Varicose aneurysm (Spence).

bend of the elbow, the vessels being injured during venesection. The condition may occur in the neck, the axilla, the extremities, or the groin. I assisted Professor Keen in an operation upon an aneurysmal varix of the common carotid and internal jugular vein, and assisted Professor Hearn in operating on a varicose aneurysm involving the external iliac vessels. Sir Frederick Treves operated on a case involving the internal maxillary vessels. Very rarely an arteriovenous aneurysm forms spontaneously. Spontaneous arteriovenous aneurysm is most frequent between the aorta and vena cava. There is no tendency to spontaneous cure in arteriovenous aneurysm. Edema is the rule, muscular atrophy is common, and ulceration or even gangrene of a limb may occur. Matas has collected 17 cases of arteriovenous aneurysm of the subclavian vessels ("Transactions of Am. Surg. Assoc.," vol. xix). In this list is the celebrated case of his own, a traumatic (gunshot) arteriovenous aneurysm in which cure followed operation; in the operation it was necessary to obliterate the artery by ligatures, but the venous orifice was closed by sutures without obliterating the lumen of the vein. In the analysis of Matas's paper 15 cases are used, 2 having been noted too late for incorporation; 9 of the cases resulted from "stab or penetrating cut wounds," 6 from bulletsin 5 of the cases the brachial plexus was injured. In 8 out of the 11 unoperated cases the time after the injury when symptoms of arteriovenous aneurysm was noted is stated; in 1 signs were definite within four hours, in 3 they were noted on the second day, in 3 on the third day, in 1 on the sixth day, in I on the eighth day, in I on the ninth day, and in I a few days later. In 3 of the 15 cases secondary hemorrhage followed the injury. Eleven of the 15 cases were treated expectantly; 1 died from secondary hemorrhage and sepsis 3 weeks after the injury and 10 "survived the immediate effects of the injury, their wounds healing after the cessation of the primary hemorrhage."

In 4 of the 15 cases operation was performed. In 3 the operation was done soon after the injury because of violent secondary hemorrhage. In 1 (Matas's own case) operation was done deliberately to prevent complications. Three of these cases recovered (including Matas's); 1 died of renewed secondary hemorrhage on the twenty-fourth day after operation. Matas points out the fact that in stab wounds of the subclavian vessels the largest proportion of cases die of primary hemorrhage before assistance is obtained, but in a considerable number of cases temporary hemostasis occurs, which is followed by secondary hemorrhages or arteriovenous aneu-

rysm.

Symptoms of Aneurysmal Varix.—The arterial blood is cast forcibly into the vein and as a consequence the vein becomes enlarged, tortuous, and thickened. The scar of a wound is almost invariably apparent. At the seat of vascular trouble the most marked dilatation exists and it is of bluish color. The tumor pulsates markedly, imparts a sensation to the finger like that felt when the hand is laid upon the back of a purring cat. This thrill or vibration is very characteristic. A sound of a hissing or buzzing nature can be easily heard. The tumor at once disappears on pressure being made upon it or on the artery between it and the heart. It is diminished in size by raising the limb, is increased in size by a dependent position of the limb and by compressing the vein between the heart and the tumor. The adjacent veins are dilated and often the dilatation is manifested over a wide area above and below (Fig. 178), and the thrill and bruit are transmitted a considerable distance. If an extremity is involved it is usually edematous. The parts as a rule are painful. The condition progresses, but very slowly, and sometimes vears may elapse without any notable aggravation.

Symptoms of Varicose Aneurysm.—In this condition we find many of the symptoms of aneurysmal varix, but in varicose aneurysm pressure over the artery of supply between the heart and the lesion does not cause the entire disappearance of the tumor; the veins collapse, it is true, but a distinct sac

remains, which may be emptied by direct pressure.

Treatment.—The prognosis after operation is better than in ordinary aneurysm, but nevertheless it is wisest to refrain from operating on aneurysmal varix so long as the condition is not progressing obviously, is borne without inconvenience, and is not leading to complications. Varicose aneurysm should be operated upon. If we refrain from operating upon aneurysmal varix the patient should wear a support; but if the part becomes painful or if there seems to be danger of rupture of the vein, operation should be performed. Until recently, when operation was indicated, surgeons advised that each vessel should be tied above and below the opening and a portion of each vessel should be excised, the excised area including the opening. In varicose aneurysm it was the custom to tie each vessel above and below the sac, and excise the sac with a portion of each vessel. At the present time surgeons prefer the Matas operation for both varicose aneurysm and aneurysmal varix. In some cases of varicose aneurysm, however, the sac is extirpated and the openings in the vessels closed by suture, and in some cases of aneurysmal varix the adherent vessels are separated and the opening in each is sutured.

Cirsoid aneurysm, or aneurysm by anastomosis, consists in great dilatation with pouching and lengthening of one or several arteries. The disease progresses and after a time involves the veins and capillaries. The walls of the arteries become thin and the vessels tend to rupture. Cirsoid aneurysm is most commonly met with upon the forehead and scalp of young people, where it sometimes takes origin from a nevus. It is sometimes seen upon the back or upper extremity. The cause is unknown. Usually there is no assignable cause, but occasionally the condition follows an injury. Pregnancy causes a cirsoid aneurysm to grow rapidly, and so usually does the onset of puberty. Occasionally some of the enlarged vessels fuse and form a great cavity. If rupture occurs, desperate hemorrhage inevitably ensues.

Symptoms.—There is a pulsating mass, irregular in outline, composed of dilated, elongated, and tortuous vessels that empty into one another. The mass is soft, can be much reduced by direct pressure, and is diminished by compression of the main artery of supply. A thrill and a bruit exist.

Treatment.—In treating a cirsoid aneurysm the ligation of the larger arteries of supply is a wretched failure. Subcutaneous ligation at many points of the diseased area has effected cure in some cases, but it has failed in more. Direct pressure is also entirely useless. Ligation in mass has been successful. Destruction by caustic has its advocates. Electropuncture with circular compression of the arteries of supply has once or twice effected a cure. Injection of astringents has been recommended. Verneuil ligated the afferent arteries, incised the tissues around the tumor, and sank a constricting ligature into the cut. The proper method of treatment is excision after exposure and ligation of every accessible tributary of supply. In a very extensive mass extirpation is impossible; hence one of the other methods suggested must be employed. A very considerable mass can be excised, and the resulting wound should be covered with Thiersch skin-grafts.

Wounds of arteries are divided into contused, incised, lacerated, punctured, and gunshot-wounds, and vascular ruptures.

Contused and Incised Wounds .- A contusion may destroy vitality and be followed by sloughing and hemorrhage. A contusion may rupture a blood-vessel, and is especially apt to do so if the vessel is diseased. Blood is at once effused at the seat of rupture. If an artery is ruptured, there may or may not be a bruit and pulsation over the seat of rupture, pulse is absent below, and the leg below the injury swells and becomes cold. If a large vein ruptures, a blood tumor forms, which does not pulsate and has no bruit, and the limb below becomes intensely edematous. Gangrene is apt to follow the rupture of a main blood-vessel of an extremity. A contusion may rupture the internal and middle coats of an artery, the external coat remaining intact. When this happens the internal coat curls up and the middle coat contracts and retracts, the blood-stream is arrested, and a large clot forms within the artery. If the clot blocks up many collaterals, gangrene will follow, and, as has been pointed out, the gangrene will not be preceded by swelling at the seat of injury, which always occurs if a vessel is ruptured. A contused wound may do little damage, or it may produce gangrene from thrombosis, or it may cause secondary hemorrhage. In an incised wound of an artery there is profuse hemorrhage. The artery after a time is apt to contract and retract, bleeding being thus arrested. A transverse wound causes profuse bleeding, but there is a better chance for natural arrest than in an oblique or in a longitudinal wound. The clot which forms within a cut artery is known as the "internal clot." It used to be taught that the internal clot always reaches as high as the first collateral branch, and subsequently is replaced by fibrous tissue, which permanently obliterates the vessel, and converts it into a shrunken fibrous cord. As a matter of fact, when the parts are aseptic after a ligation the clot is rarely bulky and is often very scanty, repair being quickly effected by proliferation of endothelial cells. Between the vessel and its sheath, over the end of the vessel, and in the surrounding perivascular tissues is the "external clot" (Fig. 181).

A lacerated wound of an artery causes little primary hemorrhage. The internal coat curls up, the circular muscular fibers of the media contract upon it, the longitudinal fibers retract and draw the vessel within the sheath, and the external coat becomes a cap over the orifice of the vessel. All of these conditions favor clotting. The vessel-wall is so damaged that secondary hemorrhage is usual.

Punctured Wounds.—In punctured wounds primary hemorrhage is slight unless a large vessel is punctured. Secondary hemorrhage is not

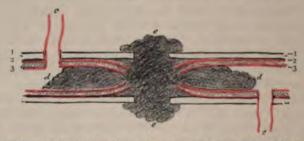


Fig. 181.—Clots formed after division of an artery: 1, 2, 3, Outer, middle, and inner coats;  $\epsilon$ ,  $\epsilon$ , branches; d, d, internal clot;  $\epsilon$ ,  $\epsilon$ , external clot.

common. Traumatic aneurysm and arteriovenous aneurysm are not unusual results.

Gunshot-wounds of arteries by pistol balls and the balls of large-caliber rifles are apt to be contusions which may eventuate in sloughing and secondary hemorrhage or thrombosis and gangrene. A shell-fragment makes a lacerated wound. A modern rifle-bullet makes a clean-cut division of an artery. Secondary hemorrhage after gunshot-wounds is most likely to occur during the third week after the injury. Partial rupture of an artery may cause sloughing and secondary hemorrhage, thrombosis and gangrene, or aneurysm. A complete rupture constitutes a lacerated wound, and is a condition accompanied by diffuse hemorrhage into the tissues.

Wounds of veins are classified as are wounds of arteries. The symptom of any vascular wound is hemorrhage.

## HEMORRHAGE, OR LOSS OF BLOOD.

Hemorrhage may arise from wounds of arteries, veins, or capillaries, or from wounds of the three combined. In arterial hemorrhage the blood is scarlet and appears in jets from the proximal end of the vessel, which jets are synchronous with the pulse-beats; the stream, however, never intermits. The stream from the distal end is darker and is not pulsatile. Venous hemorrhage is denoted by the dark hue of the blood and by the continuous stream.

In capillary hemorrhage red blood wells up like water from a squeezed sponge, and the color is between the bright red of arterial blood and the dark color of venous blood.

In subcutaneous hemorrhage from rupture of a large blood-vessel there are great swelling, cutaneous discoloration, and systemic signs of hemorrhage. If a main artery ruptures in an extremity, there is no pulse below the rupture, and the limb becomes cold and swollen. At the seat of rupture a large fluctuating swelling forms, and sometimes there are bruit and pulsation. If a vein ruptures in an extremity, a large, soft, non-pulsatile swelling arises, there is no bruit, and intense edema occurs below the seat of rupture. Profuse hemorrhage induces constitutional symptoms, and death may occur in a few seconds. Loss of half of the blood will usually cause death (from four to six pounds), though women can stand the loss of a greater relative proportion of blood than men. Young children, old people, individuals exhausted by disease, drunkards, sufferers from Bright's disease, diabetes, and sepsis stand loss of blood very badly. An individual with obstructive jaundice is apt to suffer from persistent oozing of blood after operation, an oozing which is particularly persistent and dangerous in obstruction of the bile-ducts due to malignant disease. It not unusually causes death. Generally, after bleeding has gone on for a time, syncope occurs. Syncope is Nature's effort to arrest hemorrhage, for during this state the feeble circulation and the increased coagulability of blood give time for the formation of an external clot. When reaction occurs, the clot may hold and be reinforced by an internal clot, or it may be washed away with a renewal of bleeding and syncope. These episodes may be repeated until death supervenes. Nausea exists and there may be regurgitation from the stomach. Vertigo is present. There is dimness of vision or everything looks black; black specks float before the eyes (muscæ volitantes), or the patient sees flashes of light or colors. There is a roaring sound in the ears (tinnitus aurium). The patient yawns, is restless, tosses to and fro, and great thirst is complained of. The mind may be clear, but delirium is not unusual, and convulsions often occur. After a profuse hemorrhage an individual is intensely pale and his skin has a greenish tinge; the eyes are fixed in a glassy stare and the pupils are widely dilated, and react slowly to light; the respirations are shallow and sighing; the skin is covered with a cold sweat; the legs and arms are extremely cold, and the body-temperature is below normal. The pulse is soft, small, compressible, fluttering, or often cannot be detected; the heart is very weak and fluttering, and the arterial tension is almost abolished. There is muscular tremor; the patient tosses about, and asks often and in a feeble voice for water. The suffering from thirst is terrible and no amount of water gives relief. There is often dreadful dyspnea, and a man who is bleeding to death grasps at his chest, rises up upon his elbow, and then falls back in a dead faint. Usually reaction occurs, though the patient is obviously weaker than before; again a faint may happen, and so there is fainting spell after fainting spell until death ensues. Convulsions frequently precede death. In hemorrhage the hemoglobin is greatly diminished in amount. In an intra-abdominal hemorrhage the above symptoms are noted, and, except in splenic hemorrhage, blood gathers in both loins, and dulness on percussion exists which gradually rises and shifts as the patient's position is shifted. The blood also gathers in the rectovesical

pouch in the male, and in the recto-uterine pouch in the female, and may be detected by digital examination. If the spleen is wounded, the blood clots quickly, and an area of dulness, which does not shift and which progressively increases, is noted in the splenic region.

Treatment.-When such a dangerous condition is due to an intraabdominal hemorrhage, the surgeon at once opens the abdomen and arrests bleeding while the assistants apply the treatment advised in the following remarks. If a large vessel in an extremity has been divided, temporarily arrest bleeding by digital pressure in the wound, or the application of an Esmarch band above the wound (if the bleeding is arterial). In some cases forced flexion is used. In any case lower the head, and have compression made upon the femorals and subclavians, so as to divert more blood to the brain, or bandage the extremities (autotransfusion). Apply artificial heat. The value of adrenalin in restoring or maintaining arterial tension has been demonstrated by Crile. We should give the patient by hypodermoclysis one pint of hot normal salt solution containing one dram of the 1:1000 solution of adrenalin chlorid. The fluid is allowed to run in the subcutaneous tissue beneath the breast. The infusion of one pint or more of hot salt solution into a vein is a very valuable remedy; it gives the heart something to contract upon and thus maintains cardiac action. If the depression is very severe, inject ether hypodermatically, then brandy, and then atropin. Strychnin may be given hypodermatically in doses of gr. 1/26, but atropin is of more service. Digitalin is advised by some, but it is not sufficiently rapid in action. Give enemata of hot coffee and brandy. Apply mustard over the heart and spine. Lay a hot-water bag over the heart.

In hemorrhage from a vessel of an extremity, we temporarily arrest bleeding while bringing about reaction. As soon as reaction is established permanently arrest bleeding by the ligature. In intra-abdominal or concealed hemorrhage it is not possible to temporarily arrest it and wait for reaction, but the abdomen must be opened and the work proceeded with in spite of the patient's condition. Every moment we wait he is growing worse.

A severe hemorrhage is apt to be followed by fever, due to the absorption of fibrin ferment from extravasated blood and its action upon a profoundly debilitated system. After a severe hemorrhage leukocytes are increased, not only relatively, but absolutely. Red corpuscles are diminished both relatively and absolutely. Hemoglobin diminishes; many of the corpuscles become irregular and microcytes are noticed.

In treating a patient who has thoroughly reacted after a severe hemorrhage, apply cold to the head. Fluids and ice are grateful. Frequently sponge the skin with alcohol and water. Milk punch, koumiss, and beefpeptonoids are given at frequent intervals.

Hemostatic agents comprise (1) the ligature and suture; (2) torsion; (3) acupressure; (4) elevation; (5) compression; (6) styptics; (7) the actual cautery; and (8) forced flexion of limbs.

The ligature was known to the ancients, but was rediscovered by Ambroise Paré. The ligature may be made of silk, floss-silk, or catgut. Whatever material is used must, of course, be rendered aseptic. A ligature should be about ten inches long. The vessel to be tied must be drawn out with forceps and separated for a short distance from its sheath, but must not be

separated to any considerable extent; to do so may lead to necrosis of the vessel and secondary hemorrhage. The hemostatic forceps (Figs. 182, 183,



Fig. 182.—Halsted's straight artery forceps.

184) is in most cases a better instrument than the tenaculum (Fig. 185). The tenaculum makes a hole in the vessel, and sometimes a slit-like tear. A

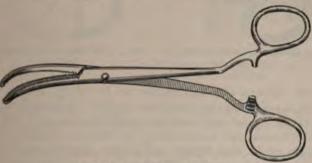


Fig. 183.-Curved hemostatic forceps.

portion of this opening may remain back of the tied ligature, the vessel may



Fig. 184.-Straight hemostatic forceps.

retract a little, or the ligature may slip slightly, and bleeding may occur. When the artery lies in dense tissues or is retracted deeply in muscle or fascia,

the tenaculum, when carefully used, is the better instrument. The ligature is tied in a reef-knot (Fig. 186), not in a granny-knot (Fig. 187), and not in a



surgeon's knot (Fig. 188). It is often the purpose of the surgeon to divide the internal and middle coats of the vessel, and if such is his desire the first knot is firmly tied. The second knot must not be tied too tightly, or it will cut the ligature. The ligature must not be jerked as it is being tied. If a third



Fig. 186.—Method of tying square or reef-knot.



Fig. 187.—Method of tying grannyknot.

knot overlies the first two, the ligature can be cut off close to the knot; otherwise it is cut off so that short ends are left. Both ends of a divided vessel should be ligated. If a vessel is atheromatous, it is not desirable to divide the internal and middle coats. In this case a ligature should be applied firmly rather than tightly, and another ligature should be put on above it, or ligation can be effected by the stay knot. If an artery is incompletely divided, a ligature should be applied on each side of the wound and the vessel divided between the ligatures.

When the parts about an artery are so thickened that the vessel cannot be drawn out, arm a Hagedorn needle (Fig. 189) with catgut and pass the

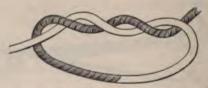


Fig. 188.-Method of tying surgeon's knot.

latter around the vessel in such a manner that the catgut will include the vessel with some of the surrounding tissue. Then tie the ligature (Fig. 191). This method is known as the application of a *suture-ligature*, and is pursued in necrosis, atheroma, scar-tissue, sloughing, etc. Never include a nerve of any size in the ligature. If this mode of ligation fails, we may try acupressure.

Doyen, when about to tie a thick pedicle, crushes it by means of a very powerful instrument and then ties a ligature about the crushed and attenuated area. The vessels are closed by laceration wide of the ligature and the ligature does not tend to slip. Some trust such a stump without a ligature,

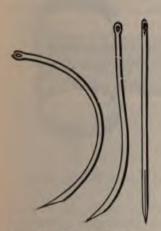


Fig. 189.—Hagedorn's needles.



Fig. 190.—Method of controlling hemorrhage by ligature (after Esmarch): a, Artery ligated; b, lateral ligature of vein.

but most surgeons prefer to ligate. This instrument is known as the vasotribe or angiotribe and is used particularly in hysterectomy. Fig. 192 shows a vasotribe.

If a large vein is torn we wish, if possible, to control hemorrhage without obliterating the lumen of the vein. If the wound is not greater in length than



Fig. 191.—Arrest of hemorrhage by passing a suture-ligature.

the measure of the diameter of the lumen, a lateral ligature may be used. It is practically always used in small transverse wounds. In order to apply a lateral ligature the two lips of the vein wound are seized by forceps and drawn out into a tit (Figs. 190 and 207). A ligature is placed around the base of the cone and tied. The pull in the cone is relaxed while the first knot is being tied in order that the ligature may constrict tightly. In a large vessel the thread should be passed

by a needle through the outer coats of the vein before it is used to encircle the cone. This plan prevents slipping.

Phleborrhaphy is suture of a vein, with preservation of the lumen of the vessel. It is used when complete ligation is undesirable (as in a large vein), and when lateral ligation without obliteration of lumen is impossible. It is commonly employed for longitudinal wounds and for wounds in any direction when the length of the wound is greater than the diameter of the vessel. Fine catgut or silk may be used. An intestinal needle threaded with silk is entirely

satisfactory. The thread is passed through the external coat and part of the middle coat on each side of the wound. Interrupted sutures are employed and thus the two lips of the wound are approximated. A vein completely divided



Fig. 192.-Vasotribe of Doyen.

across can be united by end-to-end suturing. Fig. 193 shows the operation of phleborrhaphy.

By suturing I successfully closed a tear in the innominate vein inflicted during the removal of a retrosternal goiter, and also a considerable longitudinal tear in the internal jugular vein inflicted during the removal of lymph-nodes.

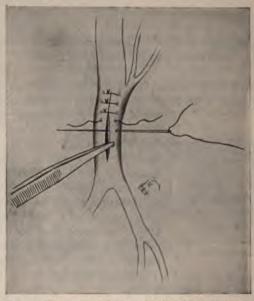


Fig. 193.—Phleborrhaphy: Forceps are seen everting lip of wound for passage of needle and interrupted sutures (Bickham).

Murphy and Damar Harrison each succeeded in suturing a wound of the inferior vena cava.

Arteriorrhaphy.-The studies of Carrel, Murphy, Matas, Abbe, and

others have shown that wounded arteries can be repaired by suturing; that a portion of an artery can be removed and repair be obtained by end-to-end suturing, implantation, or lateral anastomosis; that an artery can be obliterated by suturing the intima from within; that an artery can be anastomosed into a vein, and that after resection of a portion of an artery vascular integrity may be restored by suturing into the gap a portion of a vein or artery recently resected.

We now suture many wounds in large vessels which until very recently would have caused us to completely ligate the artery. In extirpating malignant tumors it may be necessary to remove large arteries or veins. This causes

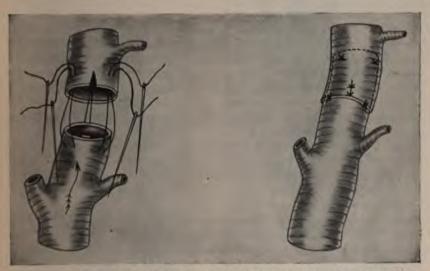


Fig. 194.—Arteriorrhaphy in complete circular division of an artery (Murphy's method):
A, Intussusceptum, with sutures passing through outer and middle coats; B, intussuscipiens (split to aid invagination), with sutures passing through all coats; C, showing all sutures used (Bickham).

grave danger of gangrene and we now attempt to prevent gangrene by the restoration of vascular continuity.

The wonderful experiments of Carrel on the transplantation of organs and the brilliant studies and operations of Murphy have been the great influences that have brought vessel suture into the field of practical surgery.

There is yet much to learn. What we do know is really little, but we are probably at the threshold of great events.

We know that we can close by suture a lateral wound or a transverse wound of less than half the circumference of the vessel; that we can perform end-to-end suturing; that we can insert a piece of resected vein to re-establish vascular continuity; and that after such an operation the blood-current will be re-established. We do not know how long the circulation will continue after re-establishment. A sutured artery will certainly carry blood for a time, but in most cases, at least, only for a time, the ultimate fate of the vessel being obliteration by endothelial proliferation. If the vessel operated upon is diseased,

obliteration by clot is practically certain to ensue. But even temporary reestablishment of circulation is of the greatest value. Even though the lumen is finally closed, the closure is gradual. While the vessel is closing the collaterals are dilating. By the time one source of supply for the tissues is cut off, another has taken its place. Thus gangrene is prevented. There appears to be a

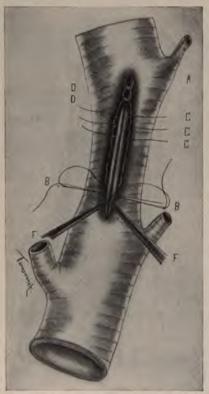


Fig. 195.—Repair of longitudinal wound of artery by combination cobbler's stitch through all coats, and interrupted sutures through outer coats, as suggested by the author: A, Beginning of cobbler's stitch through all coats; B, B, needles in act of passing through same opening in opposite directions, in characteristic cobbler fashion; C, C, three interrupted sutures through outer coats, ready to be tied; D, D, two interrupted sutures tied, passing through outer coats (Bickham).



Fig. 196.—Repair of complete transverse division of artery by combination cobbler's stitch through all coats, followed by interrupted sutures through outer coats, as suggested by the author: A, A, Needles passing in opposite directions through all coats, in act of placing cobbler's stitch; B, superficial tier of interrupted stitches through outer coats, showing three untied and two tied (Bickham).

certain amount of danger of the development of aneurysm at the seat of suturing. In a longitudinal wound of an artery or in a transverse wound of not over half the circumference of the vessel, the wound may be closed by interrupted sutures, passing the threads through the two outer coats and bringing the wound edges together without inversion. Floss silk is used, and it should be as large

as the eye of a curved conjunctival needle will carry to lessen the danger of leaking of blood through the stitch holes. The sheath is sutured over the stitch line ("Bickham's Operative Surgery").

A better plan in such wounds is that of Bickham, viz.: A cobbler's stitch through all the coats to bring the intima of each lip together and interrupted sutures through the outer coats (Fig. 196). An oblique wound may be repaired in the same manner. If a vessel is divided transversely through more than half of its circumference Murphy believes that the division should be made complete as a preliminary to suturing.

Complete circular division may be treated by Murphy's plan, viz., invagination of one end of the cut vessel into the other end split to receive it (Figs. 194

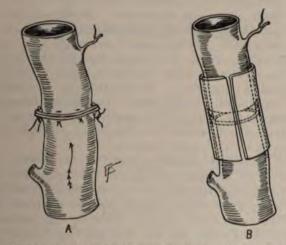


Fig. 197.—Circular arteriorrhaphy in complete division of an artery: A, Method of Salomoni and Tomaselli—interrupted sutures through all coats; B, method of Gluck—interrupted sutures through outer coats, protected by cylinder of decalcified bone, ivory, or rubber (Bickham).

and 196), by Bickham's plan of a cobbler's stitch followed by interrupted sutures, or by the plan shown in Fig. 197.

Depage has successfully sutured the common carotid artery ("Journal de Chir. et Ann. de la Soc. Belge de Chir.," Jan. and Feb., 1902). Pringle sutured a wound of the external iliac artery. The wound was one-quarter of an inch in length. During the operation pressure was made upon the aorta ("Scottish Med. and Surg. Jour.," Oct., 1901). Dujemil Pasha successfully sutured a lacerated wound of the axillary artery ("General Surgety," by John B. Murphy, 1905, p. 127). Torrance sutured a brachial artery on the eighth day after a crush ("Annals of Surgery," July, 1904). The author successfully sutured a small laceration in the axillary artery. Stewart removed a clot from the femoral and sutured the vessel. Murphy removed a clot from the external iliac and sutured the vessel. Braun ("Zentral-blatt für Chirurgie," August 29, 1908) resected a portion of the aorta along with

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no particular advantage. It is no quicker than the ligature, and damages the vessel so much that necrosis may occur. It cannot be used if the vessels are diseased. In what is known as free torsion the vessel is grasped, drawn out and twisted until the free end of the vessel is twisted off. Limited torsion is more often used. The vessel is drawn out of its sheath by a pair of forceps held horizontally, and is grasped a little distance above its extremity by another pair of forceps held vertically (Fig. 198). The first instrument is used to twist the artery six to eight times.

Acupressure is pressure applied by means of a long pin. The method of hemostasis by acupressure was devised by Sir James Y. Simpson. A pin



Fig. 198.-Method of controlling hemorrhage by torsion.

is simply passed under a vessel (transfixion), leaving a little tissue on each side between the pin and vessel. A pin can be passed under a vessel, and a wire be thrown over the needle and twisted (circumclusion). The pin can be inserted upon one side, passed through half an inch of tissues up to the vessel, be given a quarter-twist, and be driven into the tissues across the artery (torsoclusion). Some tissue may be picked up on the pin, folded over the vessel, and pinned to the other side (retroclusion). Acupressure is occasionally used to arrest hemorrhage in inflamed or atheromatous vessels, in sloughing wounds, in scar-tissue, and when a ligature will not hold firmly.

Elevation is used as a temporary expedient or in association with some other method. It is of use in a wound of a bursa, in bleeding from a ruptured varicose vein, and is frequently used with compression.

Compression is either direct or indirect—that is, in the wound or upon its artery of supply. In the removal of the upper jaw arrest bleeding by plugging. In injury of a cerebral sinus, plug with gauze. Compression and hot water (115°-120° F.) will stop capillary bleeding. A graduated compress was formerly recommended in hemorrhage from the palmar arch. A compress will arrest bleeding from superficial veins. The knotted bandage of the scalp will arrest bleeding from the temporal artery. Long-continued pressure causes pain and inflammation.

Indirect compression is used to prevent hemorrhage or to temporarily arrest it. It may be effected by encircling a limb above a bleeding point with an Esmarch band or by applying a tourniquet or an improvised tourniquet (Fig. 201). It may also be effected by a clamp. Crile has devised a clamp to effect temporary closure of the carotid artery. In operations about the head

one or both carotids may be closed for a considerable time and bleeding may thus be largely prevented. In 10 cases Crile temporarily closed both carotids. A hypodermatic injection of atropin is given to prevent inhibition, the vessels are exposed, and the clamps are applied with just sufficient firmness to approximate the vessel-walls. No clot will form if the walls are not compressed.

Fig. 199. —Tamponade of intercostal artery (after Von Langenbeck).

The patient is in the Trendelenburg position. If it is found that respiratory difficulty occurs, one clamp must be loosened. After the completion of the operation the patient must be brought to the horizontal before the clamps are removed (Crile, in "Annals of Surgery," April, 1902).

Digital compression is a form of indirect compression. It can be maintained for only a few minutes by one person, but a relay of assistants can



Fig. 200.—Conical aseptic tampon compressing an artery (Senn).

carry it out for a considerable time. In compressing the subclavian artery, wrap a key as shown in Fig. 202, and compress the artery against the outer surface of the first rib. The shoulder must be depressed and pressure applied

in the angle between the posterior border of the sternocleidomastoid and the upper border of the clavicle. The direction of the pressure should be downward, backward, and inward.



Fig. 201.—Impromptu tourniquet for compressing an artery with a handkerchief and a stick.



Fig. 202.—Handle of door-key, padded.

The brachial artery can be compressed against the humerus. In the upper part of the course of the artery the pressure should be from within outward (Fig. 203), in the lower part from before backward (Fig. 204). The abdominal aorta can be compressed by Macewen's method (q. v.). The common iliac can be compressed through the rectum by means of a round piece of wood known as Davy's lever. The femoral artery can be compressed just below Poupart's ligament against the psoas muscle and head of the femur

(Fig. 205). The pressure should be directly backward. In the middle third of the thigh digital compression is unsatisfactory, and a tourniquet should always be used or an

Esmarch band be employed.

Forced flexion is a variety of indirect compression introduced by Adelmann. It will arrest bleeding below the point compressed, but soon becomes intensely painful. Forced flexion can be maintained by bandages. Brachial hyperflexion is maintained by tying the forearm to the arm. It is often associated with the use of a pad in front of the elbow.



Fig. 203.-Digital compression of the brachial artery.

Genuflexion is maintained by tying the foot to the thigh. It is increased in efficiency by placing a pad in the popliteal space.

Styptics.—Chemicals are now rarely used to arrest hemorrhage. In epistaxis we may pack with plugs of gauze saturated with a 10 per cent. solution of antipyrin. In bleeding from a tooth-socket freeze with chlorid of ethyl spray, and then pack with gauze soaked with 10 per cent. solution of antipyrin or pack with dry sponge or styptic cotton (absorbent cotton soaked in Monsel's



Fig. 204.—Digital compression of the brachial artery.



Fig. 205.—Digital compression of the femoral artery.

solution and dried). A bit of cork may be forced into the socket. In bleeding from an incised urinary meatus pack with styptic cotton and compress the lips of the meatus. Cold water, chlorid of ethyl spray, and ice act as styptics by producing reflex vascular contraction. Hot water produces contraction and coagulates the albumin. The temperature should be from 115° to 120° F. A mixture of equal parts of alcohol and water stops capillary oozing.

The Use of Gelatin in Controlling Hemorrhage.—It seems very positively proved that gelatin increases the coagulability of the blood, if given hypodermatically. It has been shown by Horatio C. Wood, Jr. ("American Medicine," May 3, 1902), that, even when administered by the stomach, digestion does not destroy its coagulating effect upon the blood. Carnot, of Paris, used it locally and with success to control epistaxis in a sufferer from hemophilia. He then employed it to arrest bleeding from hemorrhoids, tumors, and incised wounds; and demonstrated in animals that it will arrest oozing from the cut surface of the liver. Carnot used a 5 or 10 per cent. solution. It has been employed with success to control hemorrhage in many situations, is of value when applied locally, and possibly of use when injected subcutaneously.

Intravenous injections are extremely dangerous, and are apt to be followed by embolism. Subcutaneous injections are decidedly painful, and are not altogether safe, producing albuminuria and occasional embolism. Another danger that may follow the subcutaneous administration of gelatin is the development of tetanus, and several cases have been reported. The existence of disease of the kidneys contraindicates the hypodermatic use of

gelatin.

It has been successfully used as an enema in intestinal hemorrhage, and as an injection in hemorrhage from the bladder. I have used it with success in arresting bleeding from the cut surface of the human liver; to check bleeding from an incised wound in a victim of leukemia; to arrest the post-operative oozing in sufferers from cholemia; and in several cases of severe epistaxis.

When employed locally in solution, it should be of a strength of from 2 to 5 per cent. in normal salt solution. For hypodermatic use some employ a 5 per cent., some a 2 per cent., and some a 1 per cent. solution. In using a 1 or 2 per cent. solution a very large amount of fluid must be injected. This causes pain; and Sailer maintains that the pain is slight or absent, if the solution is not turbid and if but 10 c.c. of a 10 per cent. solution are injected. The injection may be repeated until from 1 to 3 gm. of gelatin have been administered. It should be injected on the outer side of the thigh, under the breast, or between the shoulder-blades. If the drug is given by mouth, 100 c.c. of a 10 per cent. solution is the dose; and this may be repeated every two or three hours.

On account of the possible danger of the development of lockjaw, great care in sterilizing must always be exercised. The method of preparation suggested by Joseph Sailer will be found of the greatest value. (For the formula for this see page 420).

In view of the fact that gelatin is such an excellent culture-material, whenever it is used in the rectum, nose, pharynx, vagina, or bladder, it should

be mixed with some antiseptic agent.

The exact mode in which gelatin acts in producing coagulation is not certain. Floresco maintains that it acts like an acid. Laborde states that undissolved particles of gelatin serve as centers for coagulation. Other experimenters insist that gelatin destroys the leukocytes. and thus liberates fibrin ferment.

Suprarenal extract is a valuable agent to control capillary oozing. It constricts capillaries, and if applied to a mucous membrane will rapidly blanch it. It is extensively used to check bleeding during operations on the nose, throat, larynx, and ear, and to arrest epistaxis and bleeding from the uterus. The solution to employ is adrenalin chlorid of a strength of from 1:10,000 to 1:1000. A piece of cotton soaked in this solution is pressed lightly upon the part or it is sprayed upon the part by an atomizer ("Practical Therapeutics," by H. A. Hare).

Chlorid of calcium, given internally, favors coagulation of the blood and is used to check oozing or to prevent hemorrhage. It is used particularly in jaundice cases when operation must be performed. If given several times a day for two or three days it increases the coagulability of the blood; but if given for more than four days, actually diminishes it. The initial dose is

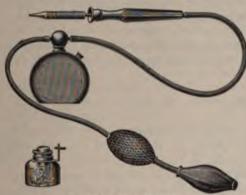


Fig. 206.-Paquelin cautery.

from 15 to 30 grains, then gr. v every hour are given until five or six doses have been taken. It is apt to provoke gastric irritability, and it is often advisable to give it by the rectum.

The actual cautery is a very ancient hemostatic. It is still used occasionally after excising the upper jaw, in bleeding after the removal of some malignant growths, in continued hemorrhage from the prostatic plexus of veins after lateral lithotomy, and to stop oozing after the excision of venereal warts. We are often driven to its use in "bleeders"—that is, those persons who have a hemorrhagic diathesis, and who may die from having a tooth pulled or from receiving a scratch. It will arrest hemorrhage, but the necrosed tissue separates, and when it separates secondary hemorrhage is apt to set in. The iron for hemostatic purposes must be at a cherry heat. The old-fashioned iron, which was heated in a charcoal furnace, is rarely used. It is large, clumsy, and cools quickly if the bleeding is profuse. In an emergency we may heat a poker or a coil of telegraph wire. The best instrument is the Paquelin cautery. The Paquelin cautery consists of an alcohol lamp, a metal chamber containing benzene, a tube of entrance for air containing two bulbs, an exit tube, and a wooden-handled cautery instrument, the tip of which is hollow

and composed of platinum (Fig. 206). This can be kept hot even when bleeding is profuse. If the iron is very hot, it will not stop bleeding completely. In order to use the Paquelin cautery, light the lamp, heat the cautery-tip in the flame, until it becomes red, remove it from the flame, and squeeze the bulb repeatedly until the tip becomes bright red. Each time the bulb not covered with netting is squeezed air is driven through the metal chamber into the tube and cautery, and this air carries with it the vapor of benzene, which passes to the hot tip and takes fire. The degree of heat maintained depends upon the rapidity with which the bulb is squeezed.

Skene has devised a method known as electrohemostasis. He grasps the vessel or tissue with specially constructed forceps, an electric current generates heat, the tissue is cooked, and the walls of the vessel united. A heat of from 180°-190° F. is required. For the small instrument Skene uses a current

of 2 ma. and for the larger instrument a current of 8 ma.\*

Downes has devised an instrument to apply electrothermic hemostasis in abdominal and pelvic operations. He asserts that by this method an intraabdominal operation can be rendered bloodless; that the lymph-ducts are sealed and the stump is sterile; that adhesions are less apt to form; and that there is less post-operative pain than if the ligature were used ("Boston Med. and Surg. Jour.," July 10, 1902).

Rules jor Arresting Primary Hemorrhage.—1. In arterial hemorrhage tie the artery in the wound, enlarging the wound if necessary (Guthrie's rule). In tying the main artery of the limb in continuity for bleeding from a point below we fail to cut off the bleeding from the distal extremity, and hemorrhage is bound to recur. If the surgeon does not look into the wound, he cannot know what is cut: it may be only a branch, and not a main trunk. The same rule obtains in secondary hemorrhage.†

2. We can safely ligate veins as we would arteries.

In a wound of the superficial palmar arch tie both ends of the divided vessel.

4. In a wound of the deep palmar arch enlarge the wound, if necessary, in the direction of the flexor tendons, at the same time maintaining pressure upon the brachial artery. Catch the ends of the arch with hemostatic forceps and tie both ends. If the artery can be caught by, but cannot be tied over the point of, the forceps, leave the instrument in place for four days. If the artery cannot be caught with forceps, use a tenaculum. The ends of the divided vessel can be caught and must be caught even if large incisions are needed to effect it. An incision which will probably always expose the vessel is as follows: Make a cut on a line with the injury from the web of the fingers to above the carpus, separating the metacarpal and carpal bones, until the artery is reached. (This is really Mynter's incision for excision of the wrist.) In former days, if the surgeon found trouble in grasping the ends of the vessel, he applied a graduated compress (Fig. 200). This is applied as follows: Insert a small piece of gauze in the depths of the wound, put over this a larger piece, and keep on adding bit after bit, each successive piece larger than its predecessor, until there exists a conical pad, the apex of which is at the point of hem-

<sup>\*</sup> New York Medical Journal, Feb. 18, 1898.

<sup>†</sup> For Murphy's observations on anastomosis of vessels, see page 444.

orrhage and the base of which is external to the surface of the palm. Bandage each finger and the thumb, put a piece of metal over the pad, wrap the hand in gauze, place the arm upon a straight splint, apply firmly an ascending spiral reverse bandage of the arm, starting as a figure-ofeight of the wrist, and hang the hand in a sling. Instead of applying a splint, we may place a pad in front of the elbow and flex the forearm on the arm. The palmar pad is left in place for six or seven days unless bleeding continues or recurs. The graduated compress is unreliable, hence it is a dangerous method of treatment. It is an evasion. It should be employed at the present time only as a temporary expedient, until ligatures can be applied. The old rule of surgery was as follows: If bleeding is maintained or begins again after application of a graduated compress, ligate the radial and ulnar arteries. If this maneuver fails, we know that the interosseous artery is furnishing the blood and that the brachial must be tied at the bend of the elbow. If this fails, amputate the hand. At the present day it is hard to conceive of such radical procedures being necessary for

5. In primary hemorrhage, if the bleeding ceases, do not disturb the parts to look for the vessel. If the vessel is clearly seen in the wound, tie it;

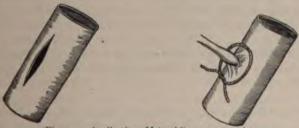


Fig. 207.-Application of lateral ligature to a vein.

otherwise do not, as the bleeding may not recur. This rule does not hold good when a large artery is probably cut, when the subject will require transportation (as on the battle-field), when a man has delirium tremens, mania, or delirium, or when he is a heavy drinker. In these cases always look for an artery and tie it.

- 6. When a person is bleeding to death from a wound of an extremity, arrest hemorrhage temporarily by digital pressure in the wound and apply above the wound a tourniquet or Esmarch bandage. Bring about reaction and then ligate, but do not operate during collapse if the bleeding can be controlled by pressure.
- 7. If a transverse cut incompletely divides an artery, it may be found possible and may be considered desirable to suture the cut. Longitudinal cuts can certainly be sutured. If suturing is impossible, or if the surgeon prefers not to attempt it, apply a ligature on each side of the vessel-wound and then sever the artery so as to permit of complete retraction.
- 8. If a branch comes off just below the ligature, tie the branch as well as the main trunk.
- 9. If a branch of an artery is divided very close to a main trunk, the rule used to be, tie the branch and also the main trunk. It was thought that if

the branch alone were tied, the internal clot, being very short, would be washed away by the blood-current of the larger vessel. We now know that the clot is not required in repair, and under aseptic conditions it is trivial in size and rarely reaches the first collateral branch. Repair is effected by endothelial proliferation.

- ro. If a large vein is slightly torn, put a lateral ligature upon its wall (Fig. 207). Gather the rent and the tissue around it in a forceps and tie the pursed-up mass of vein-wall. It is a wise plan to pass the ligature through the two outer coats by means of a needle and tie the knot subsequently. This expedient prevents slipping. If a longitudinal wound exists in a large vein, take an intestinal needle and fine silk and sew it up with a Lembert suture. Transverse wounds can also be sutured.
- 11. When a branch of a large vein is torn close to the main trunk, tie the branch, and not the main trunk. Apply practically a lateral ligature.
- 12. If, after tying the cardial extremity of a cut artery, the distal extremity cannot be found, even after enlarging the wound and making a careful search, firmly pack the wound.
- 13. In bleeding from diploë or cancellous bone, use Horsley's antiseptic wax, or break in bony septa with a chisel, or plug with threads of gauze or scrapings of catgut. If the bleeding is very free, wax will not stick and mashing the bone edges usually fails. The expedient suggested by Vaughan should then be employed, viz., a piece of muscle or other tissue is cut off, and, by means of the fingers or a knife handle, forcibly rubbed against the bleeding bone surface. Minute fragments of the soft tissue plug the open vessels and arrest the bleeding (George Tully Vaughan, in "Jour. Am. Med. Assoc.," Nov. 9, 1907).
- 14. In bleeding from a vessel in a bony canal, plug the canal with an antiseptic stick and break the wood, or fill up the orifice of the canal with antiseptic wax or a separated bit of tissue. If this fails, ligate the artery of supply.
- 15. In bleeding from the internal mammary artery the old rule was to pass a large curved needle holding a piece of silk into the chest, under the vessel and out again, and tie the thread tightly; but it is better to make an incision and ligate the artery.
- 16. In bleeding from an intercostal artery make pressure upward and outward, by a tampon (Fig. 199), or throw a ligature by means of a curved needle entirely over a rib, tying it externally; or, what is better, resect a rib and tie the artery.
- 17. In collapse due to puncture of a deep vessel, the bleeding having ceased, do not hurry reaction by stimulants. Give the clot a chance to hold. Wrap the sufferer in hot blankets. If the condition is dangerous, however, stimulate to save life.
  - 18. In punctured wounds, as a rule, try pressure before using ligation.
- 19. After a severe hemorrhage always put the patient to bed and elevate the damaged part (if it be an extremity or the head).
- 20. A clot which holds for twelve hours after a primary hemorrhage will probably hold permanently; but even after twelve hours be watchful and insist on rest.
- 21. If recurrence of a hemorrhage from a limb is feared, mark with anilin or iodin the spot on the main artery where compression is to be applied,

apply a tourniquet loosely, and order the nurse to screw it up and to send for the physician at the first sign of renewed bleeding. This must often be done in gunshot wounds.

22. When the femoral vein is divided high up, the advice commonly given is to ligate the vein and also the femoral artery. Braune taught that because of the venous valves there is no collateral circulation, and to tie the vein alone renders gangrene inevitable. Niebergall shows that the valves may be overcome by moderate arterial pressure, and thus collateral circulation be established. Hence, when the femoral vein is divided tie the vein, but leave the artery untied, so as to furnish the necessary pressure.\*

23. In extradural hemorrhage, trephine. The side to be trephined is determined by the symptoms, and not by the situation of the injury. The opening is made on a level with the upper orbital border and one and a quarter inches behind the external angular process. This opening exposes the middle meningeal and its anterior branch. If this does not expose a clot, trephine over the posterior branch, on the same level and just below the parietal eminence. When the clot is found, enlarge the opening with the rongeur, scoop out the clot, and arrest the bleeding by passing catgut ligatures on each side of the injury in the vessel through the dura, under the artery and out again, and then tying them. If the artery lies in a bony canal, plug the canal with Horsley's wax. In subdural hemorrhage open the dura and endeavor to ligate. If this procedure is impossible, pack with one piece of iodoform gauze.

24. In hemorrhage from a cerebral sinus catch the edges of the opening with forceps, if possible, and apply a lateral ligature, or leave the forceps in place for forty-eight hours, or compress firmly with one large piece of iodoform gauze.

25. In extramedullary spinal hemorrhage rapidly advancing and threaten-

ing life perform a laminectomy and arrest the hemorrhage.

26. In bleeding from a tooth-socket use chlorid of ethyl spray or ice. If this treatment fails, plug with gauze infiltrated with tannin or soaked in antipyrin solution of a strength of ro per cent., or in Carnot's solution of gelatin, close the jaws upon the plug, and hold them with Barton's bandage. If this expedient fails, soak the plug in Monsel's solution, or plug with a bit of cork or dry sponge, and if this is futile, use the cautery. Pressure on the carotid and ice over the jaw and neck are indicated. It may be necessary to tie the external carotid artery.

27. In intra-abdominal hemorrhage open the belly. In intra-abdominal hemorrhage it is necessary to operate during shock. If the blood accumulates so rapidly as to prevent the location of the bleeding point, compress the aorta or pack the abdominal cavity with large sponges. In seeking for the bleeding-point remove the sponges one by one, or have the pressure momentarily relaxed from time to time. In parenchymatous hemorrhage from the liver try packing with iodoform gauze. If this fails, suture the torn edge or use the cautery. Severe wounds of the spleen demand splenectomy. Wounds of the kidney may be sutured, but may require partial or complete nephrectomy. Mesenteric vessels are ligated en masse with silk (Senn). Wounds of the stomach and intestines causing hemorrhage require stitching of their edges. When there are a great many points of bleeding, take a number

<sup>\*</sup> Niebergall, Deut. Zeit. f. Chir., vol. xxxvii, Nos. 3 and 4.

of sponges, tie a piece of tape firmly to each one, pack many places in the belly with the sponges, bring the tapes out of the wound, and remove the sponges from below upward one at a time, securing the bleeding points as they come into view.

28. In abdominal section for disease of the female pelvic organs bleeding is limited by the clamp or by pressure-forceps. Ligation en masse is often practised. Use silk. A large mass can be transfixed and tied in sections. Bleeding edges are stitched. Areas of oozing are treated with temporary pressure and hot water, or, if this fails, by the cautery. Packing can be used as a tamponade, which is a gauze pouch, pieces of gauze being packed into this pouch after its insertion into the belly (Fig. 42).

29. A ruptured varicose vein requires a compress, a bandage from the

periphery up, and elevation.

30. Most cases of capillary bleeding can be controlled by compression with gauze pads soaked in water at a temperature of 115° to 120° F. This contracts the vessels and seals them with coagulated albumin. Keetly in 1878 impressed the profession with the value of hot water as a styptic. Centuries ago surgeons used hot oil for the same purpose. Capillary bleeding can often be controlled by the application of gauze soaked in Carnot's solution



Fig. 208.-Plugging the nares for epistaxis (Guerin).

of gelatin. A solution of suprarenal extract may control capillary oozing. If other means fail to control capillary hemorrhage, the cautery must be used. Understand that the term capillary bleeding does not so much mean bleeding from genuine capillaries as it does bleeding from arterioles and venules.

31. Pressure above a wound arrests arterial hemorrhage, but aggravates venous bleeding. Pressure below a wound arrests venous hemorrhage, but increases arterial bleeding. Remember these facts when applying pressure.

32. A moderate epistaxis may be arrested by an injection of peroxid of hydrogen, an injection of a solution of antipyrin, or an injection of Carnot's solution of salt and gelatin. Favorite domestic expedients are keeping the arms raised above the head and applying ice to the back of the neck. In

severe epistaxis, or bleeding from the nose, examine the nose by means of a head-mirror and a speculum. If a little point of ulceration is found, touch it with a hot iron. If the bleeding is a general ooze, if it is high up, or if the cautery does not arrest it, pack the nares. It may be necessary to pack one nostril or both. Pass a Bellocq cannula (Fig. 208) along the floor of one nostril into the pharynx, project the stem into the mouth, tie a plug of lint or gauze wet with Carnot's solution of salt and gelatin to the stem, and withdraw it. Hold the double string which emerges from the nostril in the hand and pack gauze wet with gelatin solution from before backward. Tie the strings together over the plug; if both nostrils are plugged, the strings from one nostril are fastened to the strings from the other. Do not use subsulphate of iron, as it forms a disgusting, clotty, adherent mass. If a Bellocq cannula is not obtainable, push a soft catheter into the pharynx, catch it with a finger, pull it forward, and tie the plug to it. Remove the plug in two or three days. Do not leave it longer. It blocks up decomposing fluids and may lead to blood-poisoning. Pick out the front plug first, hold the string of the second plug in the hand, push the plug back into the pharynx, catch it with forceps, and withdraw plug and string through the mouth.

33. In gunshot-wounds the primary hemorrhage is slight unless a large vessel is cut. The bleeding may be visible or may be internal (concealed), the blood running into a natural cavity or among the muscles. Capillary oozing is arrested by very hot water and compression. Venous bleeding is usually arrested by compression. If a large vessel is the source of bleeding, enlarge the wound and tie the vessel. If the artery cannot be found in the wound, tie the main trunk.

34. In prolonged bleeding from a leech-bite try compression over a plug saturated with alum or with tannin. If this fails, pass under the wound a harelip pin and encircle it with a piece of silk. If this fails, use the actual cautery or excise the bite and suture the incision.

35. In severe bleeding from the ear elevate the head, put an ice-bag over the mastoid, give opium and acetate of lead, and, if blood runs into the mouth, plug the Eustachian tube with a piece of catheter.

36. Umbilical hemorrhage in infants requires pressure over a plug containing tannin, alum, or gelatin solution. If compression fails, pass harelip pins under the navel and apply a twisted suture. If this fails, use the actual cautery.

37. Rectal bleeding requires elevation of the buttocks, insertion of pieces of ice, ice to the anus and perineum, astringent injections (alum), and the internal use of opium and acetate of lead. If these means fail, plug the bowel over a catheter, or insert and inflate a Peterson bag or a colpeurynter, or tampon and use a T-bandage. If the bleeding persists or if a considerable vessel is bleeding, stretch the sphincter, catch the bowel and draw it down, seize the vessel, and tie it if possible; if not, leave the forceps in place. Failing in this, the actual cautery must be used.

38. Subcutaneous hemorrhage, if severe and persistent, demands that an incision be made and ligatures be applied.

39. Bleeding from a cut urethral meatus requires the insertion of styptic cotton and the application of pressure. Moderate bleeding from the deeper urethra can usually be arrested by a very warm bougie, by very warm injections, or by tying a condom over a catheter, and, after inserting it, inflat-

ing the condom by blowing through the catheter and plugging the orifice of the instrument, thus using pressure. Sitting with the perineum on a thickly folded towel is useful. Ice to the perineum does good. The patient can lie down, have a folded towel applied to the perineum, and a crutch-handle pushed upon the towel, the lower end of the crutch being jammed against the foot of the bed. If a solid bougie has been first introduced, firm pressure can be made by this method. If these means are futile, perform an external urethrotomy and reach the bleeding point.

40. Hemorrhage from the prostate requires hot injections, the introduction of a large bougie first dipped in very warm water, and the retention of a catheter for two days. Perineal section may be required, or suprapubic

cystotomy with packing which does not occlude the ureteral orifices.

41. Vesical hemorrhage usually ceases spontaneously, in which case the urine must be drawn off and the viscus be washed out frequently with a solution of boric acid, to prevent septic cystitis. If blood-clots prevent the flow of urine, break them up with a catheter or a lithotrite and inject vinegar and water, a 2 per cent. solution of carbolic acid, or a solution of bicarbonate of sodium. Perfect quiet is to be maintained, cold acid drinks given, ice-bags put to the perineum and hypogastric region, and opium with acetate of lead, or gallic acid to be given by the mouth. If the hemorrhage is severe or persistent, perform a suprapubic cystotomy, wash out the bladder, and, if necessary, plug the bladder with gauze, leaving the ureters uncovered.

42. In hemorrhage after lateral lithotomy, ligate if possible. If the vessel can be caught but cannot be ligated, leave the forceps in place. If it is not possible to catch the vessel with forceps, use a tenaculum. If



Fig. 209.-Cannula à chemise.

the tenaculum fails, pass a threaded curved needle through the tissues around the vessel and tie the ligature (suture ligature). Plugs of ice and injections of hot water may be tried. These means failing, pressure is indicated. Take a cannula, fasten to it a chemise (Fig. 209), empty clots from the bladder, insert the instrument into the viscus, and pack gauze between the sides of the cannula and the chemise. The chemise is bulged out and pressure is made. Tie the cannula by means of tapes to a T-bandage. Pressure is thus combined with vesical drainage. Buckstone Brown makes pressure by inflating a rubber bag with air. The hot iron may occasionally be demanded.

43. Renal bleeding requires ice to the loin, tannic acid and opium, gallic acid or sulphuric acid internally, and perfect quiet. The use of a cystoscope will show from which ureter blood is emerging. If the bleeding threatens life and the diseased organ is identified, make a lumbar incision, and

suture or perform nephrectomy; if not sure which organ is diseased, perform an exploratory laparotomy.

44. Vaginal hemorrhage requires the ligature or the tampon.

45. Severe uterine hemorrhage (unconnected with pregnancy) requires the tampon. Persistent hemorrhage due to morbid growths may require

removal of the tubes and appendages, ligation of the uterine and ovarian

arteries, or hysterectomy.

46. Hematemesis, or bleeding from the stomach, is treated by the swallowing of ice, giving tannic acid (dose, 20 or 30 grains) or Monsel's solution (3 drops). Gelatin by the mouth is recommended. Never give tannic acid and Monsel's solution at the same time, as they mix and form ink. Opium is usually ordered. Acetate of lead and opium and gallic acid are favorite remedies, and ergot is used by many. Give no food by the stomach. If life is threatened by bleeding from an ulcer, open the belly and excise the ulcer and suture the wound. If severe hemorrhage follows injury, perform an exploratory laparotomy. Always remember that furious and even fatal gastrointestinal hemorrhage may be due to cirrhosis of the liver, and a slight injury may be the exciting cause of such a hemorrhage. In this condition, of course, operation is useless.

47. In bleeding from the small bowel give acetate of lead and opium, sulphuric acid, or Monsel's salt in pill form (3 grains), allow no food for a time, and insist on liquid diet for a considerable period. If hemorrhage threatens life, do a celiotomy and find the cause. If ulcer exists, excise it and suture, or suture a perforation without previously excising. If violent

hemorrhage follows injury, explore to discover the cause.

48. In bleeding from the large bowel, use styptic injections (10 grains of alum or 5 grains of bluestone to 5j of water). If bleeding is low down, use small amounts of the solution; if high up, large amounts. Do not use absorbable poisons. In dangerous cases perform an exploratory operation to find the cause. (For rectal bleeding see 37, p. 455.)

49. Hemoptysis or bleeding from the lung, is treated by morphin hypodermatically, by perfect rest, by dry cups or ice over the affected spot if it can be located, and by the administration of gallic acid, which drug aids coagulation.\* Of late, nitrite of amyl by inhalation has given good results.

50. In hemorrhage from wound of the lung do not open the chest unless life is threatened. If life is endangered, resect a rib, allow the lung to collapse, and see if this arrests bleeding. If bleeding still continues, remove several ribs, find the bleeding point, ligate or employ forcipressure. A small cavity may be packed with gauze. If a large surface is bleeding, fill the pleural sac with gauze and pack more gauze against the oozing surface.†

Reactionary or Recurrent Hemorrhage (called also Consecutive, Intermediate, or Intercurrent).—This form of hemorrhage comes on during reaction from an accident or an operation—that is, during the first forty-eight hours, but usually within twelve hours. It is bleeding from a vessel or vessels which did not bleed during the shock which accompanied operation, and which vessels were overlooked and not tied. It may be due to faultily applied ligatures. It is favored by vascular excitement or hypertrophied heart. The bleeding is rarely sudden and severe, but is usually a gradual drop or trickle. The Esmarch apparatus is not unusually the cause. The constricting band paralyzes the smaller arteries, which do not bleed during shock and do not contract as shock departs; hence bleeding comes on with

<sup>\*</sup>The use of ergot is a general but questionable practice. Bartholow and others hold that this drug does harm; it contracts all the arterioles, and hence more blood flows from an area where there is damage. Purgatives do good in bleeding from the lung by taking blood to the abdomen and lowering blood pressure.

† See author's case, Annals of Surgery, Jan., 1898.

reaction. To lessen the danger of the Esmarch apparatus use a broad constricting band rather than a rubber tube. After an amputation, when the larger vessels have been tied, gauze pads wet with hot water (115° to 120° F.) should be placed between the flaps. This not only arrests capillary oozing, but stimulates vessels and shows points of bleeding which were not previously visible, and these points are ligated. During reaction after an amputation, if slight hemorrhage occurs, elevate the stump and compress the flaps. If the hemorrhage persists or at any time becomes severe, make pressure on the main artery of the limb, open the flaps, turn out the clots, find the bleeding point, ligate, asepticize, close, drain, and dress. In any severe reactionary hemorrhage open the wound at once and ligate.

Secondary hemorrhage may occur at any time in the period between forty-eight hours after the accident or operation and the complete cicatrization of the wound. Secondary hemorrhage may be due to atheroma, to slipping of a ligature, to inclusion of nerve, fascia, or muscle in the ligature, to sloughing, to erysipelas, to septicemia, to pyemia, to gangrene, and to overaction of the heart. The great majority of cases of secondary hemorrhage are due to infection, and the application of modern surgical principles has rendered secondary bleeding a rare calamity. If during an operation the vessels are found atheromatous, a thread should be passed, by means of a Hagedorn needle, around the vessel, including a cushion of tissue in the loop of the ligature (this prevents cutting through, Fig. 101). Acupressure may be used in such a case. If the surgeon decides to employ the ligature, he must not tie tightly, but must endeavor to approximate the coats rather than to cut them. Two ligatures can be applied or the stay-knot may be used. One great trouble with atheromatous arteries is that their coats cannot contract; another trouble is that the ligature cuts entirely through them. If after an operation the pulse is found to be forcible, rapid, and jerking, give aconite, opium, and low diet. The bleeding may come on suddenly and furiously, but is usually preceded by a bloody stain in woundfluids which had become free from blood.

Treatment of Secondary Hemorrhage.-Suppose a case of legamputation in which, several days after the operation, a little oozing is detected: the treatment is to elevate the stump, apply two compresses over the flaps, and carry a firm bandage up the leg. If the bleeding is profuse or becomes so, make pressure on the main artery, open and tear the flaps apart with the fingers, find the bleeding vessel and tie it, turn out the clots, asepticize, close, drain, and dress. If the bleeding begins at a period when the stump is nearly healed, cut down on the main artery just above the stump and ligate. In secondary hemorrhage from a blood-vessel in nodular tissue, apply a sutureligature or tie higher up, or, if this fails, amputate. When secondary hemorrhage arises in a sloughing wound apply a tourniquet or an Esmarch bandage, tear the wound open to the bottom with a grooved director, look for the orifice of the vessel, dissect the artery up until a healthy point is reached, cut it across, and tie both ends. If this fails, apply a suture-ligature or use acupressure. In secondary hemorrhage from atheromatous vessels, use the suture-ligature, double ligature with a stay-knot, or employ acupressure-

Secondary hemorrhage may occur after ligation in continuity, the blood usually coming from the distal side. If the dressings are slightly stained with blood, put on a graduated compress. If the bleeding continues or is severe, make pressure on the main artery of the limb, open the wound and ligate, wrap the part in cotton, elevate, and surround with hot bottles. If this religation is done on the femoral and fails, do not ligate higher up, as gangrene will certainly occur, but amputate at once, above the point of hemorrhage. If dealing with the brachial artery, do not amputate, but ligate higher up and make compression in the wound. In a secondary hemorrhage from the innominate, tie the innominate again and also tie the vertebral.

## OPERATIONS ON THE VASCULAR SYSTEM.

Paracentesis auriculi, or tapping the heart-cavity, has been suggested for the relief of an overdistended heart from pulmonary congestion. The right auricle can be tapped. Push the aspirator needle directly backward at the right edge of the sternum, in the third interspace. This operation is not recommended, as it is highly dangerous and is of questionable value.

Paracentesis pericardii, or tapping the pericardial sac, is done only when life is endangered by effusion. Introduce the needle two inches to the left of the left edge of the sternum, in the fifth interspace, and push it directly backward (thus avoiding the internal mammary artery). The operation of tapping is extremely dangerous. The heart is lifted up and pushed forward by an effusion and the needle is apt to enter it. The puncture of a ventricle may do no harm, although it is apt to, but the puncture of an auricle is liable to be followed by fatal hemorrhage. It is wiser and safer to expose the pericardium and incise it, as is done for pericardial suppuration.

Operation for Pericardial Effusion or Suppuration.—The operation of tapping should be abandoned in favor of a safer but more radical procedure. There is no spot where we can introduce the needle with perfect safety, and the heart or pleura may be wounded; further, as Brentano shows,\* tapping will not completely empty the sac. In a purulent case tapping gives practically no chance of cure. No general anesthetic should be used. A portion of the fifth rib or the cartilage on the fifth rib should be excised, the pericardium exposed and punctured in order to determine the nature of the fluid present. If the fluid is serous, it can be drained away through a small incision, and the pericardium may either be sutured or drained with gauze. If the fluid be purulent, the pericardium should be stitched to the chest-wall and opened. Clots should be removed by irrigation with hot salt solution and a drainage-tube should be introduced.

Operation for Wound of the Heart.—In many cases it is obviously impossible to administer an anesthetic, but when possible it should be given because the movements of the patient while under the knife make operation difficult and increase bleeding. Ether may be used or we may take Hill's advice and give chloroform. Hill would give an anesthetic unless the patient is unconscious and the corneal reflex is abolished. Personally, I would be disposed to use chloroform unless the patient's general condition forbade it (see page 402). The pericardium can be exposed freely and Rotter's incision gives excellent access, although it always opens the pleura. This exposure is described by Hill in the "Medical Record," November 29, 1902, and was employed in his successful case. Begin an incision over the third rib five-eighths of an inch from the left edge of the sternum and carry it outward along the rib

<sup>\*</sup> Deut. med. Woch., Feb. 11, 1890.

for 4 inches. Begin an incision over a corresponding point of the sixth rib and carry it out for a like distance. Join the outer extremities of these cuts. Cut through the ribs and pleura with bone forceps and scissors. Raise the flap upon its hinges of cartilages, and have an assistant grasp the lung to prevent collapse. The pericardium thus exposed is opened more widely if necessary. Hill advises us to steady the heart by pressing the hand under it and lifting it. Parrozzani did this by inserting a finger in the wound. Other surgeons have used traction sutures of silk. Interrupted sutures are preferred to the continuous suture. Either silk or catgut can be used. They should be inserted with a round-edged needle, and should, if possible, be passed and tied during diastole. "As few as possible should be passed commensurate with safety against leakage, as they cause a degeneration of the muscular fiber." It does no harm apparently if they enter a heart chamber, but it is wiser not to have them do so. If the heart fails, use heart massage (L. L. Hill, in "Medical Record," Nov. 29, 1902). The pericardial and pleural sacs are cleansed with salt solution. The question of drainage is still sub judice. The pleural sac is treated according to indications in each case.

Geo. Tully Vaughan, in reporting his second case of heart suture and a table of 150 operations ("Jour. Am. Med. Assoc.," Feb. 6, 1909), mentions five methods for exposing the heart, and states that no single method has yet been agreed on as the best. The kind of operation is often determined by the external wound, and, begun as an exploration, the subsequent steps depend on the necessities which arise during its progress. The five methods mentioned by Vaughan are: (a) Through an intercostal space, with or without the division of one or two cartilages; (b) resection of one or more cartilages, with or without a portion of rib; (c) flap method across the sternum, dividing the sternum and cartilages (this avoids opening the pleura); (d) flap of cartilages and ribs with an external hinge; (e) flap of cartilages and ribs with an internal hinge.

Vaughan's table shows that in 46 patients the pericardium was drained, with 25 recoveries and 21 deaths; in 44 the pericardium was not drained, with 25 recoveries and 19 deaths; in 42 both the pericardium and pleura were drained, with 21 recoveries and 21 deaths; in 19 both pericardium and pleura were closed without drainage, with 12 recoveries and 7 deaths; in 72 the pleura was drained, with 30 recoveries and 42 deaths; in 21 the pleura was not drained, with 13 recoveries and 8 deaths. These figures would indicate that drainage should not be the rule. It should be used though if bleeding continues or if we greatly fear infection. Of course, drainage causes irritation, prevents the lung expanding, and makes secondary infection more probable (Vaughan in "Jour. Am. Med. Assoc." Feb. 6, 1000).

In Vaughan's table of 150 cases we find that 98 died and 52 recovered, a mortality of 65 per cent; 32 patients died in less than twenty hours after the operation for the injury and 15 died on the table or just after the operation. In all but 1 of these cases death was due to hemorrhage. In 1 it was due to pneumothorax on opening the pleura. The remaining 66 deaths occurred in from twenty-four hours to five months after the operation; 6 died of pleurisy, 5 of pericarditis, 21 of combined pleurisy and pericarditis, 3 of pneumonia, 3 of peritonitis, 2 of pericarditis and nephritis, 1 of pleurisy and cerebral abscess, 1 of pleurisy and wound of the tricuspid valve, 1 of pleurisy and double pneumonia, 1 of gangrene of the lung, 1 of two wounds, one of which was not

sutured, 3 of bleeding into the pleura, 2 of bleeding into the pericardium, 1 of clot in the tricuspid opening, and 15 of unassigned causes.

Cardiolysis.—As a result of pericarditis the heart may adhere to the pericardium and the pericardium to the chest wall. This condition is dangerous, and, if unrelieved, will eventually prove fatal.

Delorme has suggested that the pericardial sac be opened and the adhesions be broken down with the finger, a very dangerous procedure, which is

almost certain to inflict serious injury upon the heart.

Brauer's method consists in removing the ribs and portion of the sternum to which the pericardium adheres. The periosteum is to be removed with the bone to prevent the formation of new bone. This is the preferable operation.

Operation for Varix of Leg.—Many cases do not require operation. In some, operation is positively harmful. In some selected cases operation is very useful to remove certain complications (ulcer, eczema, etc.), and to relieve the patient from annoyance, but the operation rarely absolutely cures the condition. As Blake points out a cure cannot be claimed until at least one year has passed after operation without reappearance of the varix ("Boston Med. and Surg. Jour.," Sept. 25, 1902). The indications and contraindications are discussed on page 410. Never operate if phlebitis exists, except to treat thrombosis. After any operation for varicose veins of the leg follow Bennett's advice and keep the patient in bed for three weeks and do not let him resume active work for three weeks more ("Lancet," Nov. 22, 1902).

Trendelenburg's Operation.-I have employed this with much satisfaction in cases of varix of the leg following involvement of the saphenous in the thigh. Trendelenburg believes that in varix the valves in the saphenous become incompetent because of high central pressure. The veins of the leg distend, as they are unable to support such a long column of blood, and finally the blood begins to flow in the wrong direction in the saphenous, a "vicious circle" being established. We determine whether a case is a suitable one for Trendelenburg's operation as follows: While the patient is lying down, raise the extremity as though we intended to empty it of blood previous to amputation. After three minutes compress the saphenous vein about the lower third of the thigh by means of a moist gauze bandage, which must not be so tight as to shut off the deeper vessels. Lower the leg and have the patient stand up. If blood flows into the saphenous from above and distends the portion of the vein above the compress, the valves are incompetent and Trendelenburg's operation may be performed. The operation is performed as follows: Make an incision about four inches long over the internal saphenous vein at the junction of the lower and middle thirds of the thigh. Expose the vein, ligate each visible branch, ligate the saphenous at the lower end of the wound and also at the upper end, and remove the portion of vein included between the ligatures. By this operation the central pressure is intercepted and the dilated veins in consequence shrink. Some surgeons have advised the removal of the entire length of the long saphenous vein. If Trendelenburg's operation fails and a relapse occurs, extirpate the varicose veins of the leg.

Madelung cuts down over the varices and ligates at various points. Schede makes a circular cut (a circumcision) completely around the leg at the junc-

tion of the upper and middle thirds, the incision reaching to the deep fascia. All bleeding points are ligated and the edges of the incision are stitched together. Fergusson ties the saphenous vein near the femoral and removes a section from it. This makes the varices clearly evident. A semilunar incision is made to surround the varices, which incision reaches to the deep fascia. The flap is raised and dissected up, the vessels are tied, and the flap is sutured in place. The author of this operation claims that it is most satisfactory and certain. Phelps advises multiple ligation, which may be described as follows: At several points over the long saphenous vein he makes skin incisions in the long axis of the vessel. Each incision is two inches long. At each point two ligatures are placed one inch apart and the portion of vein between them is removed. Sir Wm. H. Bennett thinks that in ordinary cases the best operation consists in removing a portion of the long saphenous in the thigh and also in removing 3 inches of the vein from below the knee. If there are cystic dilatations above the knee he removes the saphenous from the thigh. Some local varices he dissects out ("Lancet," Nov. 22, 1902).

Open Operation for Varicocele.—The open operation is by far the

best procedure for varicocele.

The patient is placed in a recumbent position. He may be given a general anesthetic or Schleich's fluid may be injected. A fold of skin is pinched up on the scrotum, and the surgeon transfixes it in the line of the cord, so that he will have an incision about one and a half inches long running downward from below the external ring. The skin and fascia are cut with a scalpel, the veins are well exposed, and the cord is located and held aside. A double ligature of strong catgut or chromicized gut is passed under the veins by an aneurysm needle. The threads are separated one inch, tied tightly, and the ends are left long. The veins between the ligatures are excised. The two gut ligatures are tied together and cut. This shortens the cord. The scrotum is sewed up with silkworm-gut, a small drainage-tube being used for twenty-four hours.

Bloodgood points out that it is well to avoid dividing the genital branch of the genitocrural nerve which supplies the cremaster muscle. If this nerve should be divided, the cremaster will become lax and return of the varicocele will be favored. Bloodgood makes the incision over the external ring, draws the veins up and resects them. A wound so placed heals more certainly and promptly than does a wound of the scrotum. Of late years I have always

followed this plan.

Subcutaneous Ligature for Varicocele.—In this operation employ every antiseptic precaution. The patient stands, and the operator, sitting in front of him, holds the veins in a fold of skin away from the vas deferens by means of the thumb and index-finger of the left hand. A large straight needle carrying a double piece of strong silk is passed entirely through the scrotum, between the veins and the vas. The needle is again inserted at the puncture from which it emerged, is carried around under the skin and in front of the veins, and emerges at its original point of entry. The veins are thus surrounded by the silk. The patient, who now lies down, is placed under the first stage of ether, and the double ligatures are separated as far as possible from each other, tied, and cut off, the knots slipping in through the puncture. This operation presents certain dangers. The veins may be wounded and the vas or other structures may be included. In an operation

it is always best to be able to see what we are doing; and the open operation, being safe, is preferred to the subcutaneous.

Phlebotomy, or Venesection.—The instrument used in venesection is a lancet or bistoury. A fillet or tape, an antiseptic pad, and a bandage are required. A stick should be at hand for the patient to grasp.

Operation.—The patient sits on a chair "with the arm abducted, extended, and inclined outward" (Barker). The parts are asepticized and a tape is tied around the arm just above the elbow. The surgeon stands to the right of the arm, holds the elbow with his left hand, and puts his thumb upon the vein below the intended point of puncture. The patient grasps a

stick firmly and works his fingers in order to cause the veins to distend. Either the median cephalic or the median basilic may be opened (Figs. 210, 211). The median basilic is the more distinct, and is the vein usually selected. In opening it do not rut too deep, as nothing but the bicipital fascia separates it from the brachial artery. The median cephalic may be selected (we thus avoid endanger- venesection (Bernard and Huette). ing the brachial artery); under



Fig. 210.—Incisions for



(Bernard and Huette).

this vein lies the external cutaneous nerve (Fig. 211). Steady the vein with the thumb and open it by transfixion, making an oblique cut which divides twothirds of it. Remove the thumb and allow bleeding to go on, instructing the patient to work his fingers. When faintness begins, remove the fillet, put an antiseptic pad over the puncture, apply a spiral reversed bandage of the hand and arm and a figure-of-eight bandage of the elbow, and place the arm in a sling for several days.

Transfusion of Blood.—This operation has been a recognized protedure since 1824, though it has been known since 1492, when transfusion was employed in the case of Pope Innocent VIII. Its chief use was in severe hemorrhage, especially post-partum, in which it served to replace the blood lost and supplied something for the heart to contract upon until new blood formed. Senn insisted that the operation had proved an absolute failure, that it did not prevent death from hemorrhage, and that the transferred blooddements did not retain vitality. Von Bergmann maintained that after severe hemorrhage we do not need to inject nutritive elements, but do need to restore the greatly diminished intracardiac and intravascular pressure. At the present day a saline fluid is usually infused in preference to transfusing blood. In fact, the operation of transfusion had become all but extinct until Crile rerived it. The old operation exposed the patient to the danger of embolism and infection, its employment required material and instruments often difficult to obtain in an emergency, and it seemed to have no single element of value beyond that secured by the use of salt solution, except in cases overcome by illuminating gas, in which a more prolonged good effect was known to be produced than by salt solution.

Arteriovenous Anastomosis for Transfusion of Blood (Crile's Operation).—This is a method of the very greatest value in the treatment of the condition resulting from violent or prolonged hemorrhage. It is incomparably the best treatment for severe hemorrhage. It can be employed during the performance of an exhausting operation and its use will bring not a few cases to operation which, without its aid, would be esteemed inoperable. It should be used for severe typhoid hemorrhage and in jaundiced cases requiring operation, but showing very slow coagulation. It seems devoid of value in blood diseases. There are certain dangers in it unless there is time to examine the blood of both donor and recipient. It is known that admixture of certain bloods results in thrombosis. If the corpuscles of the donor are not agglutinated by the serum of the recipient, and vice versa, the operation is safe.

In Crile's operation the vascular system of the donor is united to the vascular system of the recipient, intima coming in contact with intima. This is accomplished by means of a modification of Payre's magnesium tube, Crile's

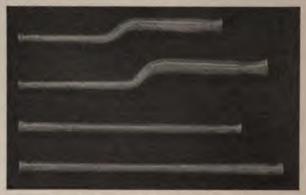


Fig. 212.—Brewer's tubes for direct transfusion.

tube being of German silver. The vein of the recipient is drawn through the tube, is everted, and is tied into the second groove on the tube.

The end of the tube with the everted vessel over it is passed into the vein of the recipient and fixed temporarily by a ligature. The left arm of each subject is usually employed and the radial artery of the donor is anastomosed to a superficial vein of the recipient. Each patient should be on a table the head of which can be raised or lowered at will. The region over the radial artery of the donor is exposed under local anesthesia. Every small branch over the artery is carefully tied in order to prevent obscuration by blood. The artery is bared for a distance of about 3 cm., tied distally, lightly clamped with a screw clamp proximally, and divided. The vein of the recipient is bared, clamped, and divided, the tube (dipped in sterile olive oil) is inserted into the vein, the cuff of everted vessel is formed over the end, and the artery is pulled over the tube and the cuff of vein, and held by a ligature tied into the first groove (see Bevan, in "General Surgery," by Lexer-Bevan).

The flow is at first slow, but after eight or ten minutes becomes more rapid, especially if warm salt solution is run into the wounds. The amount used depends on the strength of the donor and the needs of the recipient.

I have used Brewer's tube in this operation with much satisfaction. It makes the procedure vastly easier of execution. Fig. 212 shows Brewer's tubes.

I am indebted to Dr. George Emerson Brewer for describing in a note to me the technic of his operation. The description follows:

"After thorough sterilization, the tubes are prepared by dipping them in melted paraffin, shaking them out, and allowing them to cool; or, immersing them in a solution of paraffin in benzine. The radial artery of the donor is exposed in the usual manner, and also the median basilic or some other available vein of the donee. The proximal end of the artery is next drawn over one extremity of the glass tube, and secured by a silk ligature. This is facilitated by expanding the lumen of the artery by means of three mosquito forceps or artery clamps. When all is ready to insert the free extremity of the tube into the vein of the donee, the arterial clamp is temporarily released and a few jets of blood allowed to pass through the tube, which is then quickly placed within the lumen of the vein and secured by another silk ligature. If the veinof the donee is large, the distal end of the glass tube may be inserted through a longitudinal slit in the vein, after the manner usually adopted when introducing the cannula for salt infusion. When sufficient blood has been transfused the tube is removed, the vessels ligated, and the cutaneous wounds closed. In certain rare instances where it is advisable to transfuse from an adult into

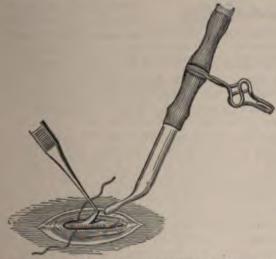


Fig. 113.-Intravenous saline infusion. Manner of incising vein and inserting glass tube (Senn).

an infant, the popliteal vein of the infant may be employed, as the subcutaneous reins are generally too small to admit of the introduction of the tube. In these cases a tube of diminishing caliber should be used, the larger end for the donor's artery, the smaller for the donee's vein."

Intravenous infusion of saline fluid is used after severe hemorrhage, in shock, in diabetic coma, in post-operative suppression of urine, and occasionally in sepsis. After a hemorrhage its beneficial effects are often prompt

and obvious. This saline fluid increases the arterial tension, gives the heart enough matter to contract upon, and so restores the activity of the circulation, and does not destroy the red corpuscles as plain water would do. We may use a simple apparatus consisting of a rubber tube, a funnel, and an aspirating needle. Some employ an Aveling syringe, and others Collin's apparatus (Fig. 214). The last-named instrument can be used without any danger of air entering with the fluids. Spencer's instrument (Fig. 215) is convenient and useful. Normal salt solution is the fluid usually employed,



Fig. 214.-Intravenous injection of saline fluid.

of a strength of o.6 per cent. (a heaping teaspoonful of common salt to a quart of warm boiled water). Some surgeons employ an artificial serum which contains 50 grains of chlorid of sodium, 3 grains of chlorid of potassium, 25 grains of sulphate of sodium, 25 grains of carbonate of sodium, and 2 grains of phosphate of sodium in a quart of boiled water. Szumann's solution consists of 6 parts of common salt, 1 part of sodium carbonate, and 1000 parts of water. The following solution is used by Locke and Hare: calcium chlorid, 25 gm.; potassium chlorid, 1 gm.; sodium chlorid, 9 gm.; sterile water sufficient to make I liter. One bottle of the commercial fluid when

diluted to I liter gives a solution of the above composition. The results from artificial serum containing many elements are no better than from normal salt solution. Whatever fluid is used, it should be at a temperature of 105° F. or over as it enters the vein. The stimulant effect of the heat is of great value. The fluid must not be allowed to cool; and a nurse gives constant attention to the temperature of the fluid in the reservoir. This degree of heat will not damage the corpuscles; in fact, Dawbarn has used saline fluid at a temperature of 118° F. without doing damage to corpuscles and with great benefit to the patient. From 1 pint to 2 pints or even more are slowly injected, the condition of the patient determining the amount given. In one case of violent hemorrhage the author used over 2 quarts. In order to infuse this fluid, tie a fillet well above the elbow, and expose by dissection the median basilic vein, or the basilic vein in the portion of its course where it is superficial to the deep fascia. Tie the vein. Incise it above the ligature, insert a fine cannula, and hold the cannula firmly in lumen by tightening a second ligature (Figs. 213, 214). Remove the fillet. Slowly and gradually introduce the fluid, carefully watching the pulse. Occupy at least ten minutes in introducing a pint, except in a very desperate case of hemorrhage, when the rapidity of the flow may be accelerated. When the tension of the pulse returns, withdraw the cannula, tie the second ligature tightly, sew up the wound, and dress it aseptically. In very severe operations an assistant should conduct the infusion while the surgeon is operating. It may be necessary to repeat the operation if the circulation

fails again. The infusion of a very large amount of saline fluid may do harm. It may embarrass the heart and cause acute dilatation, may lead to edema of the lungs or brain, and cause marked anemia which endures for days. The giving of salt solution intravenously should never be regarded as routine treatment, judgment is required in determining that it should be used, when it should be used, and how much is required, and there is a distinct , element of danger in the procedure.

Arterial Transfusion and Infusion of Saline Fluid in Arteries .-Hueter preferred the arterial method of transfusion, in order to send the blood

more gradually to the heart, and thus prevent sudden disturbance of the circulation. A little air in an artery will do no harm, and the danger of venous embolism is avoided. Saline fluid can be infused into an artery. The radial artery is exposed and surrounded by three ligatures, and the thread toward the heart is at once tied. The distal ligature is slightly tightened to cut off anastomotic blood-supply. The artery is cut transversely half through; the syringe is inserted, pointed toward the periphery, and fastened by the third ligature; the second ligature is loosened



Fig. 215.-Spencer's apparatus for the infusion of saline fluid into a vein. The cannula can be plunged directly into the vessel without preliminary incision.

and the material is injected. On finishing, the peripheral thread is tied tightly and that portion of the artery which held the cannula is excised. Dawbarn puts a hypodermatic needle into the radial artery and injects saline fluid.

Crile (Crile and Dolley, in "Jour. of Exper. Med.," Dec., 1906) has shown that when a patient is nearly dead or apparently dead that the introduction of saline fluid by a vein may overwhelm the heart. He gives it in these cases by an artery and has succeeded in resuscitating those apparently dead. The tube of the apparatus is quickly inserted into the carotid artery and toward the heart. The reservoir is raised, and as the saline fluid begins to flow the tube is punctured with a hypodermic needle and adrenalin is added to the saline stream. If the heart starts to beat blood will appear in the tube and then the administration is discontinued. By this method we may re-establish blood-pressure in the coronary arteries (see Fig. 216).

Hemophilia, Hemorrhagic Disease, or Hemorrhagic Diathesis.— The term hemophilia expresses the existence in an individual of a tendency to profuse or even uncontrollable hemorrhage spontaneously or as a result of some very trivial injury.

Hemorrhage may take place from mucous or serous membranes or from wounds of the cutaneous surface, into tissue, into organs, into a joint, under the scalp, or into the external genitals. In a hemophiliac, if a cut is made, the hemorrhage from the larger vessels is easily arrested, but capillary oozing continues.

The condition is far more common in males than in females, and if it exists in a female, which it rarely does, it is not usually provocative of dangerous hemorrhage. The disease is nearly always transmitted by heredity. It is usually transmitted to a son by a mother who is free from the disease, but whose father had it, and the son bleeds dangerously from slight causes. Some recently reported cases were transmitted in the male line (Goodall, in "Scottish Med. and Surg. Jour.," Feb., 1905). The existence of the tendency is rarely suspected until the first dentition, and possibly not till puberty; "70 per cent. of cases appear before the fifth year."\* The discovery of the existence of such a condition may not be made until a tooth is pulled, and extraction is followed by persistent bleeding. It is alleged that the tendency may disappear in middle life. The victims of this hemorrhagic tendency are called bleeders.

The cause of the condition is unknown. It has been assumed that there is a condition of the blood which prevents coagulation. There is, however, an



Fig. 216.-Injection of saline solution and adrenalin by the method of Crile.

acquired form of hemophilia. The blood changes are not characteristic. The blood is similar to that found in secondary anemia, the red corpuscles are diminished, but the hemoglobin is diminished more distinctly, hence there is a low color index. The white corpuscles are not increased as in scurvy and purpura, and often there is a positive leucopenia. Blood coagulation is slow and often imperfect. In some cases coagulation occurs in nine minutes, but in one of Wright's cases it required over an hour. It is important to remember as against failure of coagulating elements as the cause that Agnew had a case in which hemophilia was limited to the head and neck, and that there have been cases in which bleeding occurred into one joint or from one kidney. Some maintain that there is structural defect in the capillaries. In a case of hemophilia in the Jefferson Medical College Hospital, in which it was absolutely necessary to amputate a finger because of a crush, a careful study of the vessels of the finger by Dr. Coplin failed to show any disease of the

<sup>\*</sup>R. C. Cabot, in "International Text-book of Surgery."

blood-vessels. A surgeon must be on the lookout for this condition, and should inquire for it before deciding to do an operation. If it exists, only an operation of imperative necessity should be undertaken. It is now well recognized that joint lesions may occur in hemophilia (hemophilia arthritis). The condition is most common in children. As a rule, more than one joint is involved, but only a few joints suffer. In Rugh's case only one knee-joint suffered ("Annals of Surg.," May, 1907). The involvement is not of necessity symmetric.

The acute form resembles acute rheumatism and lasts about ten days. In the subacute form the temperature is lower, the symptoms less intense, and the duration shorter. In both forms joint function is restored (Frolich, "Centralb. für Chir.," 1905, vol. xxxii). The chronic form resembles tuberculous arthritis or acute osteomyelitis. In this form there is a tendency to loss of function, but there is no reaction to tuberculin.

A child who is a "bleeder" must be unceasingly watched and guarded. A tendency to profuse oozing exists in leukemia because of the condition of the blood, but this is not hemophilia. A tendency to oozing also exists during jaundice.

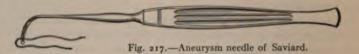
Treatment.—The oozing is difficult and often impossible to control, although most of these cases, in the long run, recover. In the acquired form the prognosis is better than in the congenital form (Weil, in "Zentralb. für Chir.," 1907, vol. xxxiv). The internal administration of such drugs as ergot, gallic acid, and acetate of lead is useless. It is claimed that chlorid of calcium internally is of service. Lactate of calcium is sometimes used by the mouth and rectum. Milk may be given by rectum in order to obtain the combination of salts of milk unchanged by gastric juice (Solt, in "Zentralb. für Chir.," 1907, vol. xxxiv). The local use of astringents is of no avail. Prolonged elevation may in rare cases succeed. In the case in the Jefferson Medical College Hospital the bleeding was arrested, after numerous expedients failed, by compression and hot water. Nurses sat by the bed for several days, constantly compressed the wound with gauze pads soaked in hot water, and changed the pads as soon as they cooled. The local use of Carnot's solution of gelatin has apparently saved several cases from death. It has been advised to take some blood from a healthy man and put it in the cut, in the hope that a firm clot will form. Thyroid extract should be tried, as in some cases it seems to have been of value. Eugene Fuller's case of hemophilia ("Med. News," Feb. 28, 1903) was apparently cured by the administration of gr. v of thyroid extract three times a day. In a recent case of hemophilia in the Jefferson Hospital thyroid extract apparently arrested the bleeding. In Rugh's case, after incision of a knee-joint, bleeding was profuse and continued, but ceased in eight days. The patient was given gr. v of thyroid extract three times a day. The cases are particularly interesting in connection with W. J. Taylor's observation that thyroid extract increases the rapidity of blood coagulation in jaundice cases and lessens the tendency to post-operative oozing in such cases. Horse serum is perhaps a promising remedy.

## LIGATION OF ARTERIES IN CONTINUITY.

The instruments used in this operation are two scalpels (one small, one medium), two dissecting forceps, several hemostatic forceps, blunt hooks or broad metal retractors, an Allis dissector, an aneurysm needle, for superfi-

cial arteries the instrument of Saviard (Fig. 217), for deep vessels the needle of Dupuytren (Fig. 218), ligatures of catgut, of chromicized gut, or of silk, curved needles and a needle-holder, sutures of silkworm-gut, and the reflector or electric forehead-lamp for deep vessels.

The **position** in which the patient is placed varies according to the vessel to be ligated, though the body is supine except when ligation is to be performed



on the gluteal, sciatic, or popliteal artery. The operator, as a rule, stands upon the affected side, cutting from above downward on the right side, and from below upward on the left side.

Operation.—Accurately determine the *line* of the artery, and make an incision at a slight angle to this line, avoiding subcutaneous veins, and holding

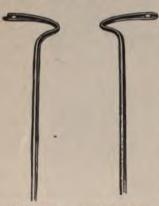


Fig. 218.—Dupuytren's aneurysm needles.

the scalpel like a fiddle-bow or a dinner-knife while cutting the superficial parts, and like a pen while incising the deeper parts. On reaching the deep fascia make out the required muscular gap by the eye and finger, so moving the extremity as to bring individual muscles into action. Treves cautions us not to depend upon the vellow line of fat, which often cannot be seen in emaciated people or when an Esmarch bandage is employed; nor upon the white line due to attachment to the fascia of an intermuscular septum. In opening the deep portion of the wound relax the bounding muscles by altering the posture. Open a muscular interspace with a sharp knife, not with a dissector. Make the depths of the wound as long as the superficial incision.

Do not tear structures apart with a grooved director; cut them. Arrest hemorrhage as it occurs. Try to find the situation of the artery with the finger. Pulsation is present, but it may be very feeble and hard to detect. The artery feels like a very thin rubber tube; it is compressible, though not so easily as a vein, and when compressed feels like a flat band which is thinner in the center than at the edges (Treves). A nerve feels like a hard, round cord. The veins are soft, larger than their related arteries, and so very compressible that they can scarcely be felt when pressed upon, and compression causes distal distention. If the wound can be seen into clearly, it will be noted, as Treves asserts, that "the nerves stand out as clear, rounded, white cords; that the veins are of a purple color and of somewhat uneven and wavy contour; that the artery is regular in outline and of a pale-pink or pinkishyellow tint, the large vessels being of lighter color than the small." Each artery of the upper extremity and each artery below the knee is accompanied by two veins, known as "venæ comites." The arteries of the head and neck, except the lingual, have each a single attending vein; the lingual



Opening the Sheath for Ligation of an Artery (Guerin).
 Sheath of Artery Open (Guerin).
 Tightening the Knot in Ligation (Guerin).
 Anatomy of the Iliac Arteries, and showing the lines of incision for their ligation;
 Abernethy's incision (Guerin).
 6. Ballance and Edmunds' Stay-knots.

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has venæ comites. Most of the smaller arteries of the trunk (pudic, internal mammary, etc.) have venæ comites. These companion veins may lie on each side of the artery or in front and back of it, and they communicate with one another by transverse branches crossing the artery. On reaching the sheath pick up this structure with toothed forceps so as to make a transverse fold, and thus avoid catching the artery or vein; lift the fold to see that it is free, and open the sheath by cutting toward the edge of the forceps with a scalpel held obliquely with its back toward the vessel, thus making a small longitudinal incision (Pl. 2, Figs. 1, 2). Hold the edge of the incised sheath with the forceps; pass a metal dissector under the vessel and from the forceps; this clears one-half of the vessel. Grasp the other edge of the sheath and pass the blunt dissector all the way around the vessel. Pass an aneurysm needle under the cleared vessel, away from the forceps holding the sheath and away from the vessel's most dangerous neighbor. Thread the needle and withdraw it. If venæ comites are in the way, try to separate them; but if this proves difficult, include them in the ligature. In small vessels always include them if they are in the way, as this saves trouble. If, in passing the needle, a large vein is severely wounded (such as the femoral), Jacobson advises the employment of digital pressure in the lower portion of the wound while the artery is being tied on a level above or below that of the vein-injury, and after ligation the maintenance of pressure on the wound for a couple of days. A slight puncture in a vein merely requires a lateral ligature. A small wound can be closed with Lembert sutures of fine silk. After getting a ligature under an artery press for a moment upon the artery over the ligature, which is held taut; this pressure will arrest pulsation below if the ligature is around the main artery and there is not a double vessel. Tie the thread at right angles to the vessel with a reef-knot (Fig. 219), rupturing the internal and middle coats. As the ligature is tightened place the extended indexfingers along the ligature up to the artery (Pl. 2, Fig. 3), using the middle joints as the fulcrum of a lever by placing them against each other.

Ballance and Edmunds have recently claimed, as Scarpa and Sir Philip

Crampton did long since, that it is not necessary to divide the internal and middle coats to insure obliteration. If this claim be true, the danger of secondary hemorrhage can be greatly lessened. Holmes, however, thinks the older method the more certain of the two. Ballance and Edmunds use floss silk as a ligature material, because it is soft, broad,



Fig. 219.-Reef-knot.

and flat, and they surround the artery with a double ligature. Ballance and Edmunds thus describe the application of the stay-knot: "The best way of tying two ligatures is to make on each separately, and in the same way, the first hitch of a reef-knot, and to tighten each separately so that the loop lies in contact with the vessel without constricting it. Then taking the ends on one side together in one hand and the two ends on the other side in the other hand, constrict the vessel sufficiently to occlude it, and finally complete the reef-knot. The simplest way of completing the knot is to treat the two ends in each hand as a single thread and to tie as if completing a single reef-knot." This knot is shown in Pl. 2, Figs. 5, 6. The stay-knot

applied by this method is of great value if a vessel be atheromatous. Fig. 220 shows an arterial scar after ligation. Fig. 221 shows an intravenous scar.

The chief dangers after ligation are secondary hemorrhage and gangrene. Rigid asepsis usually prevents the first; rest, elevation, and heat antagonize the second.

Radial Artery.—The line of the radial artery is from the middle of the front of elbow-joint to the ulnar side of the styloid process of the radius. The line in the tabatière is from the apex of the styloid process to the posterior

angle of the first interosseous space (Fig. 222).

Anatomy (Pl. 3, Fig. 5).—The radial artery, though smaller than the ulnar, is the direct continuation of the brachial. It arises from the bifurcation of the brachial half an inch below the bend of the elbow, runs down the radial side of the forearm to the front of the styloid process of the radius, passes beneath the extensor muscles of the first metacarpal bone and of the first phalanx of the thumb, and over the carpus to the first interosseous space. It is crossed by the tendon of the extensor secundi internodii pollicis, enters into the palm between the heads of the first dorsal interosseous muscle, and forms the deep palmar arch. The artery in the upper two-thirds of its course is somewhat overlaid by the supinator longus muscle; in the lower one-third of the forearm it is superficial. In the upper third of the forearm it lies between the supinator longus on the outside and the pronator radii teres on the inside; in the lower two-thirds of the forearm it lies between the supinator longus on the outside and the flexor carpi radialis on the inside. Two venæ comites attend the vessel. The radial nerve is to the outer, or radial, side of the artery, well removed from the artery in the upper third, nearer to the artery in the middle third, far external to the artery in the lower third, the nerve at this point passing beneath the supinator longus muscle. The radial artery, from above downward rests upon the biceps tendon, the supinator brevis, the flexor sublimis, the pronator radii teres, the flexor longus pollicis, the pronator quadratus muscles, and the radius. The best guide to the radial artery in the forearm is the outer edge of the flexor carpi radialis muscle or the inner edge of the supinator longus muscle.

The tabatière anatomique of Cloquet, or the anatomical snuff-box, is a triangle whose base is the lower edge of the posterior annular ligament, the ulnar side being formed by the extensor secundi internodii pollicis tendon, the radial side by the extensor ossis metacarpi and the extensor primi internodii pollicis tendons; the floor consists of the trapezium, scaphoid, their dorsal ligaments, and the base of the first metacarpal bone.

Operations.—Ligation in the tabatière is a dissecting-room operation of but little practical use. The patient is placed in a recumbent position, the arm is abducted, and the forearm is placed midway between pronation and supination (Barker). The surgeon stands upon the side operated upon. An incision two inches in length is made along the radial border of the extensor secundi internodii pollicis muscle. The skin and superficial fascia are cut and some venous branches are divided. The deep fascia is incised and the vessel is easily found and tied before it passes between the heads of the first dorsal interosseous muscle (Barker).

Ligation of the Lower Third.—In this operation (Pl. 3, Fig. 6, and Fig. 222) the patient is placed supine, the arm is abducted, the forearm is supinated, is

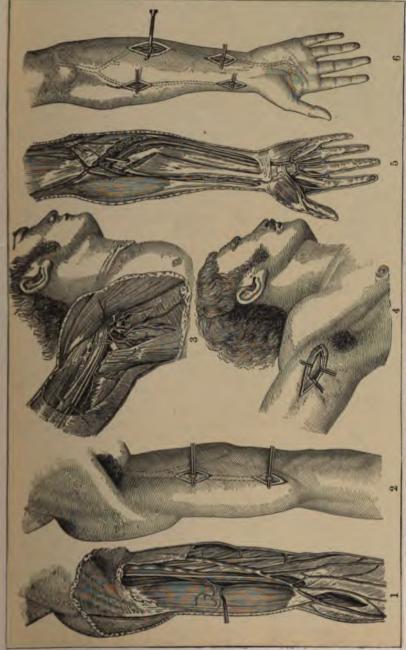
rested upon a table, and is held by an assistant. The surgeon stands on the side operated upon, and cuts from above downward on the right forearm and from below upward on the left forearm. The line of the vessel should be determined, and may be indicated with iodin or anilin. An incision one and a half inches long is made at a slight angle to this line and midway between the supinator longus and the flexor carpi radialis muscles, which incision must not extend below the level of the tuberosity of the scaphoid bone. In the superficial fascia watch for the superficial radial vein, and if it comes into view push it aside. Incise the superficial fascia and locate each guide-tendon. Open the deep fascia in the length of the first cut; try to separate the veins, but if they strongly adhere include them in the ligature. There is no special fascial sheath. The radial nerve will not be seen, but a division of the anterior cutaneous nerve is frequently found in relation with the vessel. The needle can be passed in either direction. A high origin of the superficialis volæ artery is confusing.

Ligation of the Middle Third.—In this operation the position of the patient should be the same as in the preceding. A two-inch incision is made. Veins of the subcutaneous tissues are avoided. Lying upon the deep fascia is the anterior division of the musculocutaneous nerve. Open the fascia; find the inner edge of the supinator longus muscle and draw it outward, flexing the elbow partly if necessary. Be sure not to cut external to this muscle. Find the vessel where it is bound down by connective tissue to the pronator radii teres muscle, separate the veins, and pass the ligature from without inward. The nerve is external.

Ligation of the Upper Third (Pl. 3, Fig. 6, and Fig. 222).—In this operation the incision is as described above, only higher up. The artery is between the supinator longus and the pronator radii teres, which muscles are at once differentiated by the different direction of their fibers. The artery is usually covered by the supinator longus muscle, which must be retracted externally. The nerve is not seen. The ligature may be passed in either direction.

Ulnar Artery.—No one line will overlie the entire ulnar artery. The line of the upper third runs from the middle of the front of the elbow-joint to the point of junction of the upper and middle thirds of the ulna. The line of the lower two-thirds runs from the tip of the internal condyle of the humerus to the radial side of the pisiform bone (Pl. 3, Figs. 5, 6; Fig. 222).

Anatomy (Pl. 3, Fig. 5).—The ulnar artery arises from the brachial bifurcation and runs obliquely inward under the median nerve and a group of muscles from the internal condyle; it turns down the arm, being covered in the middle third of its course by the flexor carpi ulnaris muscle. In the lower third it is superficial, between the tendons of the flexor carpi ulnaris on the inside and the flexor sublimis digitorum on the outside, the vessel being a little overlapped by the flexor carpi ulnaris. This vessel rests first upon the brachialis anticus muscle, next upon the flexor profundus, to which it is bound by a distinct process of fascia, and next upon the annular ligament, which structure it crosses to become the superficial palmar arch. Two venar comites attend the vessel. In the upper third the nerve is well internal, but in the lower two-thirds the nerve lies near the artery and to its ulnar side. The guide is the outer edge of the flexor carpi ulnaris.



1, Anatomy, 2, Ligation, of the Brachial Artery. 3, Anatomy of the Axilla. 4, Ligation of the Third Part of the Axillary Artery. 5, Anatomy, 6, Ligation, of the Radial and Ulnar Arteries. (From Bernard.)

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Operations (Pl. 3, Fig. 6, and Fig. 222).—Ligation of the Lower Third.—
The position in this operation is the same as for ligation of the radial artery.
Make a two-inch incision to the radial side of the tendon of the flexor carpi ulnaris, which incision should not be taken lower than a point one inch above the pisiform bone. Avoid the superficial ulnar vein in the subcutaneous tissue. Open the deep fascia, find the tendon of the flexor carpi ulnaris, flex the wrist and draw the tendon inward, open a second layer of fascia, clear the vessel, separate the veins, and pass the ligature from within outward to avoid the nerve. On the artery is the palmar cutaneous branch of the ulnar nerve, and this branch must not be included in the ligature.

Ligation of the Middle Third (Pl. 3, Fig. 6).—In this operation the position is the same as in the preceding one, the incision being three inches long. Avoid the anterior ulnar vein and the branches of the internal cutaneous nerve in the superficial fascia. Open the deep fascia a little external to the superficial cut (Treves). Find the space between the flexor carpi ulnaris and the superficial flexor, feeling with the index-finger, and when the space is discovered flex the wrist, retract the flexor carpi ulnaris inward and the flexor sublimis digitorum outward, open the fascia, find the ulnar nerve, look external to it for the artery, clear the vessel, separate the venæ comites, and pass the needle from within outward. The ulnar artery should not be ligated in continuity in the upper third of its course.

Brachial Artery.—The line of the brachial artery is from the junction of the anterior and middle thirds of the outlet of the axilla, the arm being abducted and the forearm supinated, to the middle of the front of the elbowjoint (Fig. 222).

Anatomy (Pl. 3, Fig. 1).—The brachial artery is the prolongation of the axillary, and extends from the lower edge of the teres major muscle to half an inch below the bend of the elbow, where it divides into the radial and ulnar arteries. It lies first to the inner side of the arm, but passes to the front of the elbow. It is crossed by no muscle, and is, in fact, superficial, barring its being somewhat overlaid in part of its course by the edge of the biceps muscle. The median nerve is external above, crosses over the vessel about the middle of the arm, and reaches the inner side of the artery. The coracobrachialis and biceps muscles are external, and both often overlap the vessel. The ulnar nerve is internal above, and the median nerve is internal below the middle. The basilic vein is to the inner side of the artery, being outside the deep fascia to near the middle of the arm, at which point it pierces it. The artery above is separated from the long head of the triceps by the musculospiral nerve and superior profunda artery and vein; it rests from above down on the inner head of the triceps, the coracobrachialis, and the brachialis anticus muscles. The artery is covered by skin, by superficial fascia, and by deep fascia. The internal cutaneous nerve lies in front of the artery, upon the deep fascia, until it pierces the fascia along with the basilic vein. The artery has venæ comites, and in its upper half has also the basilic vein to its inner side. The guide to the brachial is the inner edge of the biceps muscle. Just in front of the elbow-joint the artery lies in a triangle, the base of which is formed by an imaginary transverse line above the condyles, and the apex by the junction of the pronator radii teres and the supinator longus muscles. The outer line is the supinator longus, the

inner line is the pronator radii teres, and the floor is formed by the brachialis anticus and the supinator brevis muscles. From within outward the triangle contains the median nerve, brachial artery, tendon of the biceps, anastomosis of the superior profunda and radial recurrent arteries, and the musculospiral nerve.

Operations.—Ligation at the Bend of the Elbow.—In this operation (Pl. 3. Fig. 2, and Fig. 222) the patient is placed supine, the arm is moderately abducted and extended, and is allowed to lie upon its posterior aspect. The forearm is supinated. The surgeon stands upon the side operated upon, and cuts from above downward on the right side and from below upward on the left side. The tendon of the biceps and the median basilic vein must be accurately located. An incision is made parallel with the inner edge of the biceps tendon and two inches in length, the center of this cut being in the crease of the elbow. On exposing the median basilic vein, retract it downward and inward, open the bicipital fascia, clear the artery of fat, separate the venæ comites, and pass the ligature from within outward to avoid the median nerve. The above operation is not frequently performed.

Ligation in the Middle of the Arm (Fig. 222). - In this operation the patient is placed supine, the arm is abducted, and the forearm is supinated. An assistant holds the forearm, but the arm should not rest upon the table, because, if it be allowed to do so, the inner head of the triceps will be forced forward and may overlie the artery, and thus complicate the operation. Locate the inner edge of the biceps, which is the guide. Make an incision three inches long in the line of the artery. Incise the skin and fascia, flex the elbow slightly, retract the biceps outward, feel for the artery, open the sheath, separate its venæ comites, and, having located the median nerve, pass the ligature from it. In the middle of the arm the nerve is in front of the vessel, above the middle it is external to it, and below the middle it is internal to it. High up the arm the inner edge of the coracobrachialis is the guide, rather than the biceps. Above the middle of the arm the basilic vein is beneath the deep fascia and passes along by the inner side of the artery; hence, high up, the artery has three companion veins, the venæ comites and the basilic vein, and there is seen the ulnar nerve to the inside of the artery.

Axillary Artery.-To determine the line of the axillary artery place the arm at a right angle to the body, with the patient supine, and lay down a line from the middle of the clavicle to the humerus near the inner border of the coracobrachialis. The line of the third portion can be approximated by projecting the line of the brachial upward (Fig. 222).

Anatomy (Pl. 3, Fig. 3; Pl. 4, Fig. 1).—The axillary artery is the continuation of the subclavian, and runs from the lower margin of the first rib to the inferior border of the teres major muscle. It is divided into three portions by the pectoralis minor muscle. The first portion is above, the second portion is behind, and the third portion is below, the pectoralis minor. The position of the artery varies with the position of the limb. When the arm is parallel with the body the artery is far from the surface and forms a curve whose convexity is upward and outward. When the arm is at a right angle to the body the vessel is nearer the surface and straight. When the arm is raised above a right angle the artery comes near the surface and forms a curve with the convexity downward.

The first portion of the axillary artery is occasionally ligated. It lies upon the first intercostal muscle and the first serration of the great serratus muscle, and has behind it the posterior thoracic nerve; the brachial plexus is external and posterior to the vessel; on its inner side is the axillary vein; in front of it are the clavicle, the great pectoral muscle, the subclavius muscle, the costocoracoid membrane, the cephalic and acromiothoracic veins, and the external anterior thoracic nerve. The branches of the first part of the axillary artery are the superior thoracic and the acromiothoracic. The second part of the artery is not ligated. The brachial plexus surrounds the second portion. The third part is covered in front, above, by the great pectoral, but is covered below by skin and fascia; behind, it has the tendon of the subscapularis, the latissimus dorsi, and the teres major muscles; the coracobrachialis is on the outer side; the axillary vein is on the inner side. It is important to remember that there may be three veins, one external and two internal. The axillary vein is formed by the venæ comites of the brachial artery joining, and this new vein effecting a junction with the basilic vein. The median nerve lies upon the axillary artery in the upper part of the third portion of the vessel's course, and passes to the outer side. The musculocutaneous nerve is external, but it is only seen high up; the ulnar nerve is internal; the lesser internal and the internal cutaneous nerves are internal; the musculospiral and the circumflex nerves are behind. The branches of the third portion of the axillary artery are the subscapular and the anterior and posterior circumflex.

Operations.—Ligation of the Third Portion (Pl. 3, Fig. 4, and Fig. 222).—
The position of the patient should be supine, with the shoulders raised and the arm abducted to a right angle. The surgeon stands between the patient's arm and side, with his back toward the subject's feet. An incision is made three inches in length. It begins half-way up the axilla opposite to the head of the



Fig. 222.—Lines of incision for ligation of the axillary (third portion), brachial, radial, and ulnar arteries (MacCormac).

humerus, and is taken downward parallel to the lower edge of the great pectoral muscle and crosses the junction of the anterior and middle thirds of the outlet of the axilla. The integuments and fascia are incised. The vein or veins will be prominent to the inner side and may overlie the vessel. To the inner side with the veins are the ulnar and internal cutaneous nerves. The median nerve is upon, and the external cutaneous is to the outer side of, the artery. Feel for the pulsations of the artery, find the median nerve, and draw it outward, draw the nerves and veins which lie to the inner side inward, clear the

artery from the venæ comites, and pass the ligature from within outward.

Apply the ligature well below the circumflex branches.

Ligation of the First Part.—This operation (Pl. 4, Fig. 2, and Fig. 225) was first performed in 1815 by Chamberlaine, of Jamaica. The patient is placed supine, the upper part of the body being raised, a sandpillow being placed between the scapulæ to insure carrying back of the point of the shoulder, and the arm being brought down along the side. In operating on the left side the surgeon stands on the outer side of the left arm; in operating on the right side he stands to the right of the subject's head and leans over his shoulder. The incision, which is slightly curved downward, begins external to the sternoclavicular joint and ends internal to the margin of the deltoid, thus avoiding the cephalic vein. The incision is half an inch below the clavicle (Fig. 225). Incise the skin, platsyma myoides muscle, and deep fascia. In the outer angle of the wound watch for the acromiothoracic artery and the cephalic vein. Incise the pectoralis major; draw the pectoralis minor downward; retract the lower margin of the wound, cut through the costocoracoid membrane close to the coracoid process and the upper border of the lesser pectoral muscle. Bring the arm to the side so as to relax the structures. Find the brachial plexus, feel for the artery internal to it, clear the vessel, draw the vein internally, and pass the needle from within outward. This avoids the dangerous neighbor, which is the axillary vein. This operation is difficult, dangerous, and unusual, and in its performance the axillary vein, which has a close attachment to the costocoracoid membrane, is apt to be torn.

Subclavian Artery.—The subclavian artery was first successfully tied by Post, of New York, who applied a ligature about the third portion of the vessel in 1817. The first part of the subclavian was first tied by Colles in 1818 (Treves's "Manual of Surgery"). At the present day the first and second portions are rarely ligated. Professor Halsted successfully tied the first portion of the left side for aneurysm. Schumpert tied it successfully for aneurysm. I assisted Dr. Nassau, of St. Joseph's Hospital, Philadelphia, in a ligation of the first part of the right subclavian. The man suffered from a ruptured traumatic aneurysm of the third portion of the vessel. The operation was followed by recovery. Chilton produced a cure of an aneurysm of the third portion of the subclavian of the right side by tying the first portion and twenty-four hours later tying the first portion of the axillary. There is no line for this vessel.

Anatomy (Pl. 4, Fig. 1).—The subclavian artery of the right side arises from the innominate; that of the left side, from the arch of the aorta. The subclavian is divided into three parts. The first part runs from the origin of the vessel to the inner border of the scalenus anticus muscle; the second part lies behind the scalenus anticus muscle; and the third part runs from the outer edge of the muscle to the lower border of the first rib. The third portion is contained in the subclavian triangle (Fig. 224), and is superficial. It rises, as a rule, to half an inch above the clavicle. The subclavian vein is below the artery, being separated from it by the scalenus anticus muscle. The brachial plexus is above and external to the artery. The vessel rests upon the first rib, and behind it is the scalenus medius muscle. The suprascapular and transversalis colli arteries and veins and branches of the cervical plexus

of nerves lie in front of the artery, and the external jugular vein crosses it at its inner side. The third portion gives off no branches.

Ligation of the Third Part .- (See Pl. 4, Fig. 2, and Fig. 225). The patient is placed upon his back, the shoulders are raised, the head is extended and turned toward the opposite side, the arm is pulled down and held by pushing the forearm under the patient's back (Treves). This pulls down the clavicle, thus increasing the size of the subclavian triangle. The operator stands facing the shoulder, with his back toward the patient's feet. The skin over the subclavian triangle, at a point half an inch above the clavicle, is drawn down until it overlies the bone and is incised. This maneuver enables the surgeon to avoid the external jugular vein and to make an incision in the skin half an inch above the collar-bone. The incision reaches from the anterior edge of the trapezius to the posterior border of the sternocleidomastoid (Pl. 4, Fig. 2, and Fig. 225), and is about three inches long. This incision divides the skin, superficial fascia, the platysma myoides, the vein running from the cephalic to the external jugular, and some superficial nerves. The deep fascia is opened. The external jugular vein is drawn into the inner angle of the wound, and is not divided unnecessarily; if forced to divide the vein, tie with two ligatures and cut between them. The surgeon seeks to find the outer edge of the anterior scalene muscle, and runs the finger down along it to the tubercle on the first rib. The posterior belly of the omohyoid muscle is drawn upward by an assistant. The surgeon, with a finger on the tubercle, recalls the facts that the vein is in front of the finger and the artery is behind it, and that the subclavian vein is on a lower plane than the artery. The artery is felt beating as it lies upon the rib. The artery is cleared and the lower cord of the brachial plexus is exposed. The vein must be guarded with the finger and the needle is passed from above downward, as the plexus, which is in more danger than the vein, is to be avoided. In this operation the transversalis colli and suprascapular arteries must not be cut, as they are necessary to the future anastomotic circulation. If the field of operation is too small, the trapezius or sternocleidomastoid, or both, should be incised transversely.

Results.—According to Joseph D. Bryant, there have been 134 deaths in 250 ligations ("Operative Surgery"). I have twice tied this vessel with success.

The vertebral artery was first successfully ligated by Smythe, of New Orleans, in 1864. He had ligated the innominate for aneurysm of the subclavian and at the same time tied the common carotid. Secondary hemorrhage occurred, the blood coming from the brain. He arrested it by tying the vertebral.

Anatomy.—This vessel is the largest branch of the subclavian, and is the first branch coming from the first portion of the subclavian. The vertebral artery ascends and enters the foramen in the transverse process of the sixth cervical vertebra (in rare cases the fifth or the seventh), and ascends through foramina in the cervical vertebræ, passes behind the articular process of the atlas and over the posterior arch of this first vertebra, pierces the posterior occipito-atloid ligament, and enters the skull by way of the foramen magnum (see Gray). It joins its fellow of the opposite side to form the basilar artery. At its point of origin the vertebral artery has in front of it the internal jugular vein and inferior thyroid artery. Gray says that near the

spine it lies between the longus colli and scalenus anticus muscles, with the thoracic duct to the left and in front.

Ligation.—The position of the patient is the same as for ligation of the carotid artery. Alexander thus describes the operation: "An incision 3 or 4 inches long is made in an upward and outward direction along the hollow which exists between the scalenus anticus and the sternomastoid muscles. The incision should begin just outside and on a level with the point where the external jugular vein dips over the edge of the sternomastoid muscle, or, if the vein is invisible, about half an inch above the clavicle. The external jugular vein is drawn inward with the sternomastoid muscle. The connective tissue now appearing, the wound is opened by a blunt dissector, until the scalenus anticus muscle, the phrenic nerve, and the transverse cervical artery are seen. It cannot be too well remembered that the pleura is at the inner side of the wound, while below lies the subclavian artery. It is now only necessary to separate the edges of the scalenus anticus and the longus colli muscles to see the vertebral artery lying in the space between them. The artery is generally completely covered by the vein, which is drawn aside, and the artery is then ligatured" (quoted in Bryant's "Operative Surgery"). When the vessel is cleared and tied, branches of the inferior cervical ganglion are damaged and possibly included in the ligature, and as a consequence the pupil contracts. Jacobson tells us to remember that the phrenic nerve lies on the scalene muscle, the pleura is internal, the internal jugular, inferior thyroid, and vertebral veins are over the vessel, and the thoracic duct on the left side crosses it from within outward.

Results.—In 36 ligations of the vertebral artery there were 3 deaths

(Joseph D. Bryant).

The Inferior Thyroid Artery.—Anatomy.—The inferior thyroid artery is a branch of the thyroid axis. It ascends the neck, passes back of the carotid sheath and the sympathetic nerve, and reaches the thyroid gland. The recurrent laryngeal nerve lies behind the artery. The phrenic nerve is external to the artery and near to it in the first part of its course (up to the point of origin of the ascending cervical branch). The ascending cervical branch takes origin just before the artery begins to dip behind the carotid. In front of the beginning of the inferior thyroid artery of the left side the thoracic duct crosses. The artery is ligated in the second part of its course (between its distribution and the origin of the above-named branch).

Ligation.—The position of patient and the incision are the same as for the ligation of the common carotid artery in the triangle of necessity (page 484). After exposing the sternocleidomastoid muscle retract it outward, and then draw outward the common carotid artery and also the internal jugular vein. The inferior thyroid artery will be found a little below the carotid tubercle. It is cleared and ligated. Treves advises ligation close to the level of the carotid, so as to avoid the recurrent laryngeal nerve.

Innominate Artery.—First successfully ligated by Smythe, of New

Orleans, in 1864. It is an extremely fatal operation.

Anatomy.—The innominate artery arises from the beginning of the transverse portion of the arch of the aorta, passes to the back of the right sternoclavicular joint, and divides into the common carotid and subclavian vessels. It rests upon the trachea. It has upon its outer side the pleura, the right innominate vein, and the pneumogastric nerve. Upon its inner side are the remnant of the thymus gland and the beginning of the left carotid artery. In front of it are the inferior thyroid veins of the right side, the left innominate vein, the sternohyoid and sternothyroid muscles, the remnant of the thymus gland, and sometimes a branch from the right pneumogastric nerve.

Ligation.—Place the patient supine, with the shoulders a little raised, and the head thrown back. Carry an incision from the upper margin of the sternum for three inches along the anterior margin of the sternomastoid.



Fig. 223.—Successful ligation of the first part of common parotid and first part of subclavian for innominate aneurysm.

Make another cut of the same length along the upper border of the clavicle to meet the first cut. Dissect up the flap of skin and fascia. Divide the sternal origin and a part of the clavicular portion of the sternocleidomastoid muscle, and cut the sternohyoid and sternothyroid muscles just above their sternal origins (Joseph Bell). Retract the inferior thyroid veins. Divide the dense leaflet of cervical fascia. Find the common carotid artery, and trace back along this vessel until the innominate comes into view. Retract the left innominate vein downward. The needle is passed from without inward to avoid the right innominate vein and right pneumogastric nerve. If the needle is kept close to the artery, the pleura and trachea will not be injured.\*

See the exceedingly clear and terse account in that excellent book, "A Manual of Surgical Operations," by Joseph Bell.

Results.—Three cases have recovered out of 31 reported (Burrell's, Banks's, and Smythe's). Burrell ligated the innominate in 1895 and the patient lived over three months, dying finally from cardiac disease. Mitchell Banks's case lived over three months.

Region of the Neck.—Anatomy.—The side of the neck is that space between the median line in front and the anterior edge of the trapezius muscle behind, which space is limited below by the clavicle and above by the body of the jaw and an imaginary line running from the angle of the jaw to the mastoid process. The sternocleidomastoid muscle divides this space into an anterior and a posterior triangle, and each of the triangles is subdivided by

other structures, the anterior into four spaces and

the posterior into two (Fig. 224).

Anterior Triangle.—The anterior triangle is bounded in front by the median line of the neck, behind by the anterior margin of the sternocleidomastoid muscle, and above by the body of the lower jaw and an imaginary line drawn from the angle of the jaw to the mastoid process. This space is subdivided into four smaller triangles—namely, the inferior carotid, the superior carotid, the submaxillary, and the submental.

The inferior carotid triangle is called the "triangle of necessity," because the common carotid artery in this region is ligated, not from choice, but through force of necessity. It is bounded in front by the median line, above by the anterior belly of the omohyoid muscle and the hyoid bone, and below by the anterior edge of the sternomastoid muscle. The floor of this triangle is composed of the longus colli, the scalenus anticus, the rectus capitis anticus major, the sternohyoid, and sternothyroid muscles.



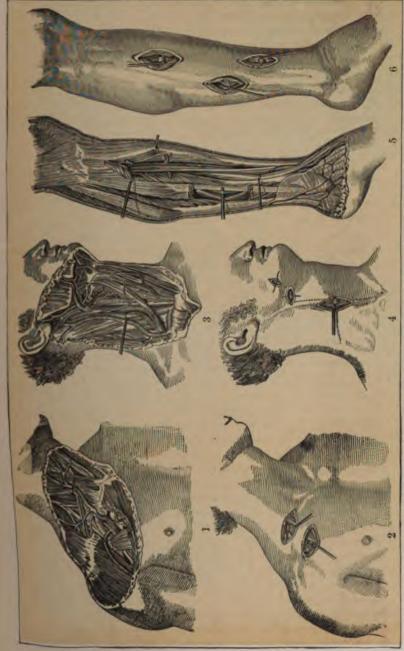
Fig. 224.—The triangles of the neck, right-sided view: 1, Submaxillary triangle; 2, "triangle of election," or superior carotid triangle; 3, submental triangle; 4, "triangle of necessity," or inferior carotid triangle; 5, occipital triangle; 6, subclavian triangle (after Keen).

The superior carotid triangle is known as the "triangle of election," because, if the carotid artery must be tied, the surgeon, whenever possible, elects or chooses to tie it in this triangle. In this region the carotid is superficial, and there can be tied either the external, the internal, or the common carotid artery, as may be desired. The triangle is bounded behind by the anterior edge of the sternocleidomastoid, above by the posterior belly of the digastric, and below by the anterior belly of the omohyoid muscles. Its floor is composed of the inferior and middle constrictors of the pharynx and the thyrohyoid and hyoglossus muscles.

The submaxillary triangle is bounded above by the body of the jaw and an imaginary line drawn from the angle of the jaw to the mastoid process, behind by the posterior belly of the digastric muscle and the stylohyoid muscle, and in front by the anterior belly of the digastric muscle. Its floor is composed

of the mylohyoid and hyoglossus muscles.

The *submental triangle* is bounded on either side by the anterior belly of one digastric muscle; its base is the hyoid bone and its floor is the mylohyoid muscle.



1, Anatomy, 2, Ligation, of the Subclavina Artery and First Part of the Axillary Artery. 3, Anatomy of the Neck. 4, Ligation of the Carotid, Lingual, and Facial Arteries. 5, Anatomy, 6, Ligation, of the Anterior Tibial and Peroneal Arteries. (From Bernard.)

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The posterior triangle is bounded in front by the posterior border of the sternocleidomastoid muscle, behind by the anterior edge of the trapezius muscle, and below by the clavicle. The posterior belly of the omohyoid muscle subdivides it into two smaller spaces, the occipital and subclavian triangles.

The occipital triangle is bounded in front by the posterior edge of the sternocleidomastoid muscle, behind by the anterior border of the trapezius

muscle, and below by the posterior belly of the omohyoid muscle.

The subclavian triangle is bounded above by the posterior belly of the omohyoid muscle, below by the clavicle, and in front by the posterior border of the sternocleidomastoid muscle. Its floor is formed by the first rib and the first serration of the serratus magnus muscle.

Common Carotid Artery.—The common carotid was tied to arrest bleeding by Abernethy in 1798, and was first ligated successfully for aneurysm by Sir Astley Cooper in 1806. The *line* of the common carotid artery is from the sternoclavicular articulation to midway between the angle of the jaw and the mastoid process, the head being turned toward the opposite side.

Anatomy (Pl. 4, Fig. 3).—The right common carotid arises from the innominate opposite the sternoclavicular joint; the left common carotid arises from the arch of the aorta. In the neck the two carotids possess identical relations. The common carotid runs upward and outward from behind the sternoclavicular articulation to a level with the upper border of the thyroid cartilage, at which point it divides into the external and internal carotid. The common carotid is contained in a sheath derived from the cervical fascia. This sheath also contains, in separate compartments, the internal jugular vein on the outer side of the artery and the pneumogastric nerve between the vein and artery, but more deeply placed. The anterior edge of the sternocleidomastoid muscle lies over the artery and is a guide. Low in the neck the common carotid is deep, being covered by skin, superficial fascia, platysma, deep fascia, and the sternocleidomastoid, sternohyoid, and the sternothyroid muscles. Above the omohyoid muscle the vessel is more superficial, being covered by the skin, superficial fascia, platysma, deep fascia, and the anterior edge of the sternocleidomastoid muscle. Upon the sheath (occasionally within it), above the crossing of the omohyoid muscle, lies the descendens noni nerve—the descending branch of the ninth pair of Willis (the hypoglossal). This nerve is a valuable guide to the sheath in the triangle of election.

The sternomastoid branch of the superior thyroid artery crosses the carotid artery a little below its bifurcation, and the superior thyroid vein also crosses it in this region; the middle thyroid vein crosses the artery near its middle, and the anterior jugular vein crosses low down. The common carotid rests upon the longus colli and rectus capitis anticus major muscles, the sympathetic nerve lying between the last-named muscle and the vessel, outside the carotid sheath. The recurrent laryngeal nerve passes behind the carotid below the omohyoid muscle, and the inferior thyroid artery passes behind the carotid just above the omohyoid muscle. The common carotid is in relation internally with the trachea, thyroid gland, larynx, and pharynx. To the outer side are the pneumogastric nerve (which is on a posterior plane) and the internal jugular vein. On the left side, low down in the neck, the jugular vein often lies in front, or partly in front, of the artery.

Ligation in the Triangle of Necessity.—In this operation the patient is placed supine, with the shoulders raised, a sand-pillow under the neck, and the head turned to the opposite side, with the chin raised. The operator stands upon the side operated upon. The incision, three inches long, at a slight angle to the arterial line, runs from the level of the cricoid cartilage downward and inward toward the sternoclavicular joint, following the inner border of the sternocleidomastoid muscle. The surgeon opens the deep fascia, draws the sternocleidomastoid outward, retracts the sternohyoid and sternothyroid muscles inward, and feels for the carotid tubercle of Chassaignac. This tubercle is the costal process of the sixth cervical vertebra, and lies directly under the artery. The tubercle is found about the point at which the omohyoid crosses the carotid. When the tubercle is found we know the situation of the artery, and that the triangle of necessity is below, and the triangle of election above, the tubercle. The operator draws the omohyoid muscle upward, opens the sheath of the artery on its inner side, clears the vessel, and passes the needle from without inward to avoid the internal jugular vein, remembering that the pneumogastric nerve is in the same sheath as the artery and vein, posterior and external to the artery. In this operation the inferior thyroid veins are much in the way, the anterior jugular vein crosses low down, and on the left side, at the root of the neck, the internal jugular vein may be in front of the carotid artery. If the incision is not sufficiently wide, partially divide the sternocleidomastoid or the sternohyoid and thyroid muscles. In the triangle of necessity the descendens noni nerve does not serve as a guide to the sheath of the vessels. (See Pl. 4, Fig. 4.)

Ligation in the Triangle of Election (Fig. 225).—The position of the patient for this operation is the same as in the preceding one. An incision, three inches in length, is made along the anterior edge of the sternocleidomastoid muscle in the line of the artery, the middle of this incision being opposite the cricoid cartilage (Fig. 225). In cutting the superficial fascia, the surgeon avoids the external jugular vein, the course of which should be outlined before making the incision. The line of the external jugular is from the angle of the jaw to the middle of the clavicle. The operator opens the deep fascia, retracts the sternocleidomastoid muscle outward, feels for the carotid tubercle, draws the omohyoid muscle downward, finds the descendens noni nerve upon the sheath, opens the sheath at its inner side, and passes the needle from without inward. This incision permits ligation of either the superior thyroid or the external, internal, or common carotid, and if it be extended up a little there can be tied through it the lingual, and even the facial and occipital, arteries

(See Pl. 4, Fig. 4.)

Results.—In from 20 to 25 per cent. of cases after ligation of the common carotid artery there is cerebral softening or some other intracranial complication. Crile states that of the cases that develop cerebral trouble, one-half die. The operative mortality, according to Crile, is only 3 per cent.

External Carotid Artery.—Burke ligated the external carotid in 1827 (Treves, from Chelius). The *line* of the external carotid artery is the upper portion of the common carotid line.

Anatomy (Pl. 4, Fig. 3).—The external carotid artery, which is one of the terminal branches of the common carotid, arises on a level with the upper border of the thyroid cartilage and runs to the level of the neck of the condyle of the lower jaw. At its point of origin it is covered only by skin, platysma, and fascia, and the edge of the sternomastoid, but as it ascends it passes beneath the digastric and stylohyoid muscles and into the parotid gland. The glossopharyngeal nerve, styloid process, and stylopharyngeus muscle lie between the external and internal carotid arteries. The hypoglossal nerve crosses the vessel just below the digastric muscle, and the facial and lingual veins cross it a little below the nerve. The first branch is the superior thyroid, which arises from the very beginning of the trunk. The lingual arises on a level with the greater cornu of the hyoid bone. The facial and occipital take origin above the lingual. Each of them can be ligated through the incision made for ligation of the external carotid.

Operation.—Place the patient in the same position as for ligation of the common carotid. The point of election is between the superior thyroid and the lingual arteries. Make an incision three inches in length at a slight angle to the arterial line, from near the angle of the jaw to opposite the middle of the thyroid cartilage. Cut through the skin, superficial fascia, platysma, and deep fascia, and retract the sternocleidomastoid muscle outward. Watch for the digastric muscle, find the hypoglossal nerve, and feel for the greater cornu of the hyoid bone. Open the sheath a little below the hyoid cornu and pass the needle from without inward. Ligation of the external carotid has been neglected because ligation of the common carotid is easier.

Results.—Crile believes the operative mortality to be 2 per cent.

Internal Carotid Artery.—The internal carotid was tied by Keith, of Aberdeen, in 1851 (Ashhurst's "International Encyclopedia of Surgery"). The line of the internal carotid is parallel with and half an inch external to the line of the external carotid.

Anatomy (Pl. 4, Fig. 3).—The internal carotid artery, the other terminal branch of the common carotid, arises on a level with the upper border of the thyroid cartilage and enters the carotid canal. The first inch of the artery is the only point where a ligature is ever applied, this point being covered only by skin, platysma, fascia, and the sternocleidomastoid muscle; higher up it is more deeply placed. It rests upon the vertebræ and the rectus capitis anticus major muscle. The internal jugular vein is in the same sheath and external to the artery; the pneumogastric is in the same sheath, between the artery and the vein, but posterior to both. The superior cervical ganglion of the sympathetic lies behind the origin of the internal carotid, and between the ganglion and the artery is the superior laryngeal nerve.

Operation.—In this operation the position of the patient is the same as for ligation of the external carotid. The incision is of the same length and direction as that for ligation of the external carotid, and is half an inch external. The sternocleidomastoid muscle is drawn outward, the external carotid artery is found and drawn inward, the internal carotid is found and cleared, and the needle is passed from without inward. The internal carotid is known by its more external position and by the fact that it gives off no branches.

Results.—There is the same danger of cerebral complications after this operation as after ligation of the common carotid. The operative mortality is probably as great.

Superior Thyroid Artery (Pl. 4, Fig. 3).—This branches off from the external carotid below the level of the greater cornu of the hyoid bone, in the triangle of election. It is primarily superficial, runs first upward and inward, next downward and forward, passes underneath the omohyoid, sternohyoid, and sternothyroid muscles, and reaches the thyroid gland.

Ligation.—The position of the patient and of the surgeon is the same as for ligation of the carotid. The artery may be reached through the incision employed for ligation of the external carotid. Gross made an incision beginning at the edge of the hyoid bone, and running downward and outward to the sternomastoid muscle. The skin and superficial and deep fasciæ are divided, and the artery is found deeply placed in the triangle of election between the carotid sheath and the thyroid gland.

Lingual Artery.—Charles Bell ligated the first part of the lingual artery in 1814. The operation beneath the hyoglossus muscle was devised by Pirogoff in 1836. (See Treves's "Manual of Operative Surgery.")

Anatomy (Pl. 4, Fig. 3).—The lingual artery arises from the external carotid opposite the greater cornu of the hyoid bone, passes beneath the digastric and stylohyoid muscles, reaches the margin of the hyoglossus muscle, passes under that muscle, and emerges from beneath it to run along the under surface of the tongue. The place of election for ligation is where the artery is beneath the hyoglossus muscle. Its guide is the hypoglossal nerve, which

lies upon the muscle, but at a slightly higher level than the artery.

Operation.—In this operation the patient is placed recumbent with the shoulders raised and the face turned away from the side to be operated upon. The surgeon stands upon the affected side. A curved incision is made from a little external to the symphysis of the lower jaw, downward and outward, to just above the greater cornu of the hyoid bone, and upward and outward to just in front of the facial artery at the lower edge of the lower jaw. The skin, the superficial fascia and platysma, and the deep fascia are incised. The submaxillary gland is cleared and retracted well upward. The fascia below the gland is divided by a transverse incision. The posterior edge of the mylohyoid muscle and the bellies of the digastric muscle are sought for and identified. One of the digastric tendons is retracted down and out (Treves). The hyoglossus muscle is cleared with a dissector; the hypoglossal nerve and ranine vein are found and drawn a little upward. The hyoglossus muscle is divided transversely a little above the hyoid bone and below the level of the hypoglossal nerve. The artery is found under the muscle and the needle is passed from above downward.

Facial Artery.—Anatomy (Pl. 4, Fig. 3).—Arises from the external carotid a little above the lingual, runs upward and forward beneath the body of the inferior maxillary bone, passes along a groove in the posterior and upper surface of the submaxillary gland, crosses the body of the lower jaw at the lower anterior edge of the masseter muscle, and passes forward and upward

to the angle of the mouth and side of the nose.

Ligation (Pl. 4, Fig. 4).—The facial artery is rarely ligated in the cervical portion, but may be reached through the incision employed for ligation of the external carotid. The vessel may be tied before it crosses the submaxillary gland, the stylohyoid and digastric muscles being drawn aside. The vessel is reached in the facial portion of its course by a one-inch cut at the

anterior edge of the masseter muscle (Fig. 225). Branches of the facial nerve are pushed aside. The needle is passed from behind forward to avoid the vein (Jacobson).

Temporal Artery.—The line of the temporal artery passes "upward over the root of the zygoma, midway between the condyle of the jaw and the tragus" (Jacobson).

Anatomy.—The temporal artery arises from the external carotid behind the condyle of the jaw and in the parotid gland, passes over the zygoma, and divides into two terminal branches.

Ligation.—The patient is placed recumbent and the head is turned to the opposite side. An incision an inch in length is made (Fig. 225), the



Fig. 225.—Position of the lines of incision of temporal, facial, lingual, common carotid (above the omohyoid), subclavian, axillary (first portion), and internal mammary arteries (MacCormac).

superficial structures and dense fascia are divided, the vein is retracted backward, and the needle is passed from behind forward.

Occipital Artery.—Takes origin from the posterior surface of the external carotid, below the digastric muscle and opposite the point of origin of the facial artery. It ascends beneath the digastric and stylohyoid muscles and parotid gland; the hypoglossal nerve hooks around it from behind forward. It crosses the internal carotid artery, the internal jugular vein, the pneumogastric and spinal accessory nerves; passes between the mastoid process of the temporal bone and the atlas; grooves the temporal bones; penetrates the trapezius muscle, and ascends over the occiput.

Ligation.—This vessel can be ligated near its origin through the same incision as is employed to reach the external carotid. The hypoglossal nerve is avoided. To tie back of the mastoid process, place the patient in the same position as for ligation of the carotid. Carry an incision from the tip of the

mastoid upward and backward, reaching a point midway between the mastoid and the occipital protuberance (Jacobson). Cut the skin, the fascia, the sternocleidomastoid, the splenius capitis, and possibly a portion of the trachelomastoid muscles. Bring the head toward the operator in order to relax the structures, retract the edges of the wound, and clear the artery where it lies between the mastoid process and the transverse process of the atlas (Jacobson). An electric forehead light is of great assistance in finding the vessel. Pass the needle away from the vein or veins (there are often several).

Dorsalis Pedis Artery.—The line of the dorsalis pedis artery is from the middle of the front of the ankle-joint to the middle of the base of the

first interosseous space.

Anatomy (Pl. 5, Fig. 1).—The dorsalis pedis is a continuation of the anterior tibial artery, and it runs from the bend of the ankle to the proximal extremity of the first interosseous space, where it divides into the dorsalis hallucis and the communicating arteries. The artery rests, from above downward, upon the astragalus, scaphoid, and internal cuneiform bones, and at its point of bifurcation lies between the heads of the first dorsal interosseous muscle. It may lie in some persons a little external to this course. It is held upon the bones by a distinct layer derived from the deep fascia. This artery is covered by skin, by superficial and deep fascia, and by the annular ligament above, and is sometimes partly overlaid by the extensor proprius pollicis muscle, and is crossed, just before its bifurcation, by the innermost tendon of the extensor brevis muscle. The inner tendon of the extensor communis digitorum is to the outer side of the vessel; the tendon of the extensor proprius pollicis is to the inner side, and is a guide. The artery is ligated in the dorsal triangle of the foot-a space which is bounded above by the lower edge of the annular ligament, externally by the inner tendon of the extensor brevis, and internally by the tendon of the extensor proprius pollicis. The artery has venæ comites; the anterior tibial nerve lies, as a rule, to its inner side, but may be found upon the artery or to its outer side, and the inner division of the musculocutaneous nerve is external to the vessel in the superficial parts.

Operation (Pl. 5, Fig. 2).—In this operation the patient is placed supine with the leg and foot extended. Heath flexes the leg partly and rests the sole of the foot directly upon the table. The surgeon stands below the extremity, and cuts from above downward. Make an incision two inches in length along the arterial line, beginning opposite the lower edge of the annular ligament and running along by the tendon of the extensor proprius pollicis; cut through the skin and superficial and deep fascia; have the toes extended; retract the tendon of the extensor proprius pollicis inward, and the tendon of the extensor communis digitorum outward; clear the artery, find the nerve, try to separate the venæ comites, and pass the needle from the nerve.

Anterior Tibial Artery.—To locate the line of the anterior tibial mark a point midway between the head of the fibula and the tuberosity of the tibia, drop one inch, and draw a line from the second point to the middle of

the front of the ankle-joint.

Anatomy.—The anterior tibial artery is one of the terminal branches of the popliteal. It arises opposite the lower border of the popliteus muscle, passes forward between the two heads of the posterior tibial muscle, comes to the front of the leg through an opening in the interosseous membrane, and

runs down to the middle of the front of the ankle-joint. In the upper twothirds of its course it rests upon the interosseous membrane, to which it is fastened by firm fascia; in the lower third it lies first upon the front of the tibia and then upon the anterior ligament of the ankle-joint. For its upper two-thirds the artery has the tibialis anticus muscle just external to it; at the junction of the middle and lower thirds the extensor proprius pollicis comes from the outside and lies either upon the artery or to its inner side for the rest of its course. Externally in its upper third is the extensor communis digitorum; in the middle third is the extensor proprius pollicis; in the lower third, the proprius pollicis having crossed to the inner side, the extensor communis digitorum again becomes the outer boundary. The artery is covered by skin and by superficial and deep fascia. In its upper third it is deeply placed between the muscles; in its middle third it is less overlaid by muscle; in its lower third it is superficial except where it is crossed by the extensor proprius and where it is covered by the annular ligament. The artery has venæ comites. In the lower three-fourths of its course it is accompanied by the anterior tibial nerve, which in its course in the upper third of the leg is external to the artery; in the middle third it is external and a little in front of the artery; and in the lower third it is external to or upon the artery (Pl. 4, Fig. 5).

Operations.—The ligations of the anterior tibial (Pl. 4, Fig. 6) are (1) of the lower third; (2) of the middle third; and (3) of the upper third. In all these ligations the patient is placed recumbent with the leg extended, and the surgeon stands to the outer side of the extremity, cutting from above down-

ward on the right side and from below upward on the left side.

Ligation of the Lower Third.—Make an incision three inches long in the line of the artery and over the annular ligament. This incision is external to the tibialis anticus muscle and half an inch from the outer border of the tibia (Barker). Divide the skin and fascia, retract the tendon of the tibialis anticus inward, and the tendon of the extensor proprius pollicis outward, along with the tendons of the extensor communis. Flex the ankle-joint to relax the tendons, and clear the artery. Draw the nerve external and pass the ligature from without inward. In order to recognize the muscles in this as in other ligations, rely largely upon the finger while the muscles are being moved.

Ligation of the Middle Third.—In this operation the procedure is similar to the above. Remember that the nerve lies in front of the vessel and that the extensor proprius pollicis muscle is external. The nerve is retracted outward and the needle is passed from the nerve. A good rule for detecting the artery is to find the outer edge of the tibia and by this locate the interosseous membrane, and then, by passing out along this membrane, discover the artery.

Ligation of the Upper Third.—Make an incision three inches long in the arterial line. On opening the deep fascia, do not rely on the eye for finding the muscular interspace, as often the latter cannot be seen, and neither a white nor a yellow line is reliable. Place the index-finger deep in the wound and have the tibialis anticus and extensor communis digitorum muscles successively rendered tense by an assistant. In opening the interspace use the handle of the knife. Relax the muscles, retract the tibialis anticus inward and draw

the extensor communis digitorum outward. Find the interosseous membrane where it is attached to the edge of the tibia, and the artery will be found upon this membrane, between the tibia and the nerve. Clear the vessel and pass the ligature from without inward to avoid the nerve.

Posterior Tibial Artery.—The line of the posterior tibial is from the middle of the popliteal space to a point midway between the tip of the

inner malleolus and the point of the heel (Pl. 5, Figs. 5, 6).

Anatomy.—The posterior tibial is the larger of the two terminal branches of the popliteal. It arises opposite the lower border of the popliteus muscle, passes down between the deep and superficial flexor muscles to midway between the tip of the malleolus and the point of the heel, and divides into the external and internal plantar vessels. In the upper third of its course it is very deeply placed midway between the tibia and fibula; in its middle third it is less deep, having passed inward; and in its lower third it is superficial. At the ankle the artery is beneath the annular ligament. From above downward the posterior tibial artery rests upon the posterior tibial muscle, the flexor longus digitorum muscle, the posterior surface of the tibia, and the internal lateral ligament of the ankle-joint. For the first inch or two of the course of the artery the posterior tibial nerve is to the inner side; the nerve then crosses to the outer side, and remains in that relative position throughout the rest of the course of the artery. When the knee is partly flexed and the leg is laid upon its outer surface the artery is between the operator and the nerve, and the nerve is between the artery and the table. Back of the malleolus, in the first compartment, lies the posterior tibial muscle; in the next compartment is the flexor longus digitorum muscle; in the next compartment are the artery and nerve; and in the most posterior is the flexor longus pollicis muscle.

Operations.—Ligation Back of the Malleolus.—In this operation the patient is placed recumbent with the thigh abducted and the leg flexed and resting upon its outer surface. The surgeon stands to the outer side. Make a two-inch semilunar incision corresponding in its curve to the malleolus and half an inch posterior to its margin (Fig. 228). Cut down to the annular ligament, incise the ligament, and find the artery and venæ comites. Clear the vessel and pass the needle from behind forward (to avoid the nerve, which is here posterior and external). Do not make the preliminary incision nearer the malleolus than half an inch, as the sheath of the tibialis posticus muscle will then surely be opened. In closing the wound, suture the ligament by buried sutures of catgut before closing the superficial parts (Pl. 5, Fig. 6).

Ligation in the Middle of the Leg.—In this operation the patient is placed in the same position as for the ligation back of the malleolus. Feel for the inner border of the tibia, and make an incision four inches long one inch behind the osseous border, parallel with it, and extending through skin and superficial and deep fascia (Fig. 228). Draw the gastrocnemius muscle outward. Incise the soleus muscle, but not the fascia beneath the soleus; cut this fascia, after dropping the handle of the knife so that the blade is at right angles with the plane of the tibia. Clear the artery; pass the needle from without inward (Pl. 5, Fig. 6).

The popliteal artery is almost never ligated in continuity. It can be tied at the upper portion of the popliteal space, at the lower portion of the popliteal space, or at the inner side of the thigh.



Anatomy (Fig. 226).—The popliteal artery is the continuation of the femoral, and runs from the opening in the adductor magnus muscle to the lower margin of the popliteus muscle. This vessel runs downward and outward behind the knee-joint and in the popliteal space. The ham, or popliteal space, is a lozenge-shaped space, which above the joint is bounded on the outer side by the biceps muscle, and on the inner side by the semitendinosus, semimembranosus, gracilis, and sartorius muscles, while below the joint it is bounded externally by the plantaris and outer head of the gastrocnemius



Fig. 226.—Anatomy of popliteal artery (Bernard and Huette).

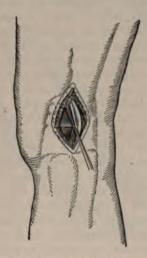


Fig. 227.-Ligation of popliteal artery in its upper third (Rernard and Huette).

muscles, and internally by the inner head of the gastrocnemius muscle. The floor of this space is formed by the surface of the femur, the posterior ligament of the knee-joint, the end of the tibia, and the popliteus fascia. The internal Popliteal nerve passes down the middle of the popliteal space; it is superficial to the vessels in the upper half of the space, and is external to them; it is internal to the vessels in the lower half of the space. The external popliteal nerve is in the outer side of the space. The popliteal vein is between the herve and the artery. Above the knee-joint it is to the outer side of the artery, but below the knee-joint it is to the inner side. The artery lies deeply in the space.

Ligation in Upper Third.—Place the patient prone. The surgeon stands to the outer side of the limb and makes a vertical incision three inches in length along the outer margin of the semimembranosus muscle, exposes the popliteal nerve, retracts the muscle inward and the nerve outward, exposes the artery, separates it from the other structures, and passes the needle from without

inward (Fig. 227).

Ligation in Lower Third.-Make a three-inch vertical incision between the heads of the gastrocnemius muscle. Avoid the external saphenous vein and nerve, and retract them with the popliteal nerve. Separate the artery from the vein and pass the needle from within outward.

Femoral Artery.—The *line* of the femoral artery is from midway between the anterior superior spine of the ilium and the symphysis pubis to the adductor tubercle on the inner condyle of the femur, the thigh being abducted and resting upon its outer surface (Pl. 5, Fig. 3).

Anatomy.—The femoral artery is the continuation of the external iliac trunk; it extends from the lower border of Poupart's ligament to the opening in the adductor magnus muscle, and hence occupies the upper two-thirds of the thigh. The artery for its first five inches is superficial, lying in Scarpa's triangle, a space which is bounded externally by the sartorius muscle and internally by the adductor longus, its base being Poupart's ligament and its floor being composed of the psoas, iliacus, pectineus, and adductor longus muscles, and often the adductor brevis. The artery enters the triangle as the common femoral, but after a two-inch course it divides into the profunda (which passes deeply) and the superficial femoral. The latter vessel is the one alluded to in this section.

At the base of Scarpa's triangle the vein is internal, the artery is between, and the nerve is external (v. a. n.). At the apex of the triangle the vein is internal and a little posterior. At the apex of the triangle the superficial femoral passes under the sartorius muscle and enters into Hunter's canal, which occupies the middle third of the thigh and which terminates at an opening in the adductor magnus muscle. Hunter's canal is bounded externally by the vastus internus muscle, internally by the adductors longus and magnus, and its roof is fascia which stretches from the adductor longus to the vastus internus. In Hunter's canal the vein is behind the artery in the upper part, but external to it in the lower part, and is firmly attached to the artery. There may be two veins. Inside Hunter's canal, but outside the femoral sheath, is the long saphenous nerve, which crosses the artery from without inward.

A way to remember the relation of the femoral vein to the femoral artery is to recall the fact that the relation of the vein to the artery is always contrary to the relation of the sartorius muscle to the artery: when the sartorius muscle is external to the artery, the vein is internal, as at the base of Scarpa's triangle; when the sartorius muscle is crossing in front toward the inside of the artery, the vein is passing at the back to the outside, as at the apex of Scarpa's triangle; when the muscle is over the artery, the vein is back of it, as in the upper third of Hunter's canal; and when the muscle is to the inside of the artery, the vein is to the outside, as in the lower two-thirds of Hunter's canal. In a ligation at the apex of Scarpa's triangle the inner edge of the sartorius is the guide. In a ligation in Hunter's canal the long saphenous nerve is the guide.

Operations.—Ligation of the Superficial Femoral at the Apex of Scarpa's Triangle.—In this operation the position of the patient is supine with the thigh and leg partly flexed, and the thigh abducted, everted, and rested upon its outer surface on a pillow. The operator stands to the outer side of the extremity. From a point corresponding to the middle of Scarpa's triangle, and two and a half inches below Poupart's ligament, make a three-inch incision in the arterial line (Fig. 228). Cut the skin and superficial fascia. The

saphenous vein will not be seen unless the incision is internal to the arterial line; if this vein is seen, draw it inward. Open the fascia lata, find the inner border of the sartorius muscle, and draw it outward. The fibers of this muscle run downward and inward, thus distinguishing it from the adductor longus, whose fibers run downward and outward. Open the common sheath for the artery and vein, and then incise the individual arterial sheath. Clear the artery and pass the ligature from within outward (Pl. 5, Fig. 4).

Ligation of the Superficial Femoral in Hunter's Canal.—This operation was first performed for aneurysm by John Hunter in 1785. In this operation



Fig. 228.—The lines indicate the incision to be made for the ligature of the common femoral, of the lemoral in Scarpa's triangle and in Hunter's canal, and of the posterior tibial in the calf and behind the malleolus (MacCormac).

the position of the patient is the same as in the ligation at the apex of Scarpa's triangle. Make a three-inch incision in the middle third of the thigh, parallel with the arterial line and half an inch internal to it (Barker) (Fig. 228). Incise the skin and superficial fascia, look out for the internal saphenous vein, open the fascia lata, find the sartorius muscle, and retract it inward, thus exposing the roof of Hunter's canal, which is to be opened for an inch or more. Within the canal is seen the long saphenous nerve, usually upon the sheath. Open the sheath of the artery, clear the vessel, and pass the needle from without inward.

Results.—Ligation at the apex of Scarpa's triangle is a method for treating popliteal aneurysm. It is a very successful procedure. I have performed it three times with success and have assisted other operators in 3 successful cases. Syme successfully ligated the femoral about its middle twenty-three consecutive times, and in Guy's hospital the same operation was done twenty-four times with 1 death ("Practice of Surgery," by Thomas D. Bryant).

lliac Arteries.—The line of the common and external iliac arteries is from a point half an inch below and half an inch to the left of the umbilicus

to midway between the anterior superior spine of the ilium and the pubic symphysis. The upper third of this line represents the common iliac, and the lower two-thirds the external iliac (Pl. 2, Fig. 4).

Anatomy.—The common iliac arteries arise from the aorta opposite the left side and lower border of the fourth lumbar vertebra, and extend to the upper margin of the right and left sacro-iliac joints, where they each bifurcate into an external and an internal iliac. The common iliac arteries lie upon the fifth lumbar vertebra, are covered with peritoneum, and are crossed by the ureters. In women the ovarian arteries cross the common iliacs. Each common iliac vein lies to the right side of its associated artery. The right common iliac artery has in front of it, besides the peritoneum and ureter (in women also the ovarian artery), the ileum, branches of the superior mesenteric artery, and branches of the sympathetic nerve. The left common iliac artery has in front of it, in addition to structures common to both sides (ureter, ovarian artery, sympathetic branches), branches of the inferior mesenteric artery and the sigmoid flexure with its mesocolon. The internal iliac artery runs from the sacro-iliac joint to the upper margin of the great sacrosciatic foramen. It is very rarely ligated (only for gluteal aneurysm, for uncontrollable hemorrhage from the gluteal or sciatic arteries, or to produce atrophy of the prostate gland). The external iliac artery runs from the sacro-iliac joint along the pelvic brim, upon the inner edge of the psoas muscle, to Poupart's ligament. The external iliac vein is internal to the artery. On the right side, high up, it passes behind the artery. The external iliac artery has in front of it peritoneum and subserous tissue (Abernethy's fascia). The ileum crosses the right, and the sigmoid flexure crosses the left, external iliac artery. The genital branch of the genitocrural nerve crosses the artery low down, and the circumflex iliac vein crosses it just before it terminates in the femoral. The spermatic vessels and the vas deferens in the male, and the ovarian vessels in the female, lie upon the artery near its termination. Sometimes the ureter crosses the vessel near its point of origin.

Ligation of the Iliac Arteries after Abdominal Section.—The best method for ligating the common, the external, or the internal iliac is by abdominal section. The patient is placed in the Trendelenburg position. The abdomen is opened in the midline below the umbilicus or in the semilunar line of the diseased side. The intestines are lifted toward the diaphragm, and are held up by gauze pads. The edges of the incision are retracted. The vessel to be tied is located and the point for ligation is selected. The posterior layer of the peritoneum is opened over the selected point, the vessel is cleared, and the threaded Dupuytren's aneurysm needle is passed in a direction away from the vein. In ligating either common iliac, pass the needle from right to left. In ligating the external iliac, pass the ligature from within outward. It is not necessary to suture the posterior layer of peritoneum. The abdomen is closed without a drain. In these operations be sure to push the ureter out of the way. This method of operating is indorsed by Dennis, Hearn, Marmaduke Shield, Mitchell Banks, and others who have employed it.

Results: Bryant ("Operative Surgery") alludes to 5 reported cases of transperitoneal ligation of the common iliac artery with 1 death.

Ligation of the Common Iliac Artery by the Extraperitoneal Method.—The common iliac artery was tied unsuccessfully by Dr. Wm. Gibson in 1812. It

was first successfully ligated by Valentine Mott in 1827. The patient is placed recumbent or in the Trendelenburg position. The body is then turned a little to the opposite side and the thighs are partly flexed. Bryant says there are two linear guides for this artery. Crampton's line is drawn from "the apex of the cartilage of the last rib downward and a little forward nearly to the crest of the ilium, then carried forward parallel with it to a little below the anterior superior spine" ("Operative Surgery," by Joseph D. Bryant). McKees' line is "drawn from the tip of the cartilage of the eleventh rib to a point an inch and a half within the anterior superior spine, then curved downward, forward, and inward, and terminating abruptly above the internal abdominal ring" ("Operative Surgery," by Joseph D. Bryant).

The incision can be begun just external to the internal abdominal ring and be curved upward and outward as in ligation of the external iliac, but Crampton's incision gives more room. The superficial tissues are divided down to the transversalis fascia, this structure is nicked and divided, and the exposed and unopened peritoneum is rolled upward and inward. The muscular guide is the inner border of the psoas magnus muscle. By its side an artery is felt. If the sacrovertebral prominence is above the vessel touched, the artery is the external iliac; otherwise it is the common iliac. If the external iliac is the vessel first exposed, follow it up to find the common trunk. When the common iliac is found, separate the fatty tissue about it and pass the ligature from the right toward the left in order to avoid the associated vein.

Results: Jos. D. Bryant tells us that this vessel has been ligated by the extraperitoneal method sixty-nine times with only 16 recoveries, but it is to be remembered that many of these operations were in preantiseptic days. The artery has been tied 80 times with 56 deaths (70 per cent.).

Twenty-one of these operations were done since 1880; there were 10 deaths (mortality of nearly 48 per cent.). In these 21 cases gangrene occurred 7 times. (See Wm. J. Gillette in "Annals of Surgery, July, 1908).

Ligation of the Internal Iliac Artery.—This operation was first performed by Stevens, of Vera Cruz, in 1812 ("Practice of Surgery," by Thomas Bryant). The incision and the method of exposing the vessel are identical with like steps in the ligation of the common iliac.

Results: Of 26 ligations of this vessel recorded, 18 were fatal, but only a few of the cases were done antiseptically (Joseph D. Bryant's "Operative Surgery").

Ligation of the External Iliac by Abernethy's Extraperitoneal Method (Pl. 2, Fig. 4).—The external iliac artery was first ligated by Abernethy in 1796. The operation failed, but he did the first successful operation in 1806. The patient is placed recumbent with the thighs extended during the first incisions; but in the later stages of the operation the thighs are flexed a little, to relax the abdominal structures. The operator stands to the outer side. The surgeon will find the artery by the side of the psoas muscle. Mark a point one inch above and one inch external to the middle of Poupart's ligament, and another point one inch above and one inch internal to the anterior superior iliac spine (Barker). Join these two points by a curved incision four inches long and convex downward. Cut the skin, the fat, the two oblique muscles, and the transversalis muscle; open the transversalis fascia, separate the peritoneum

toward the vessels, and draw it inward by a broad retractor, and look for the artery along the pelvic brim. The anterior crural nerve is seen to the outer side of the artery, the external iliac vein is to the inner side of the artery, and the genitocrural nerve is upon the artery. Clear the artery near its middle and pass the ligature from within outward. In Sir Astley Cooper's method

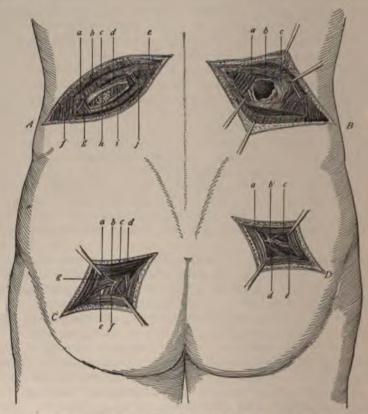


Fig. 229.—A, Nephrotomy:  $a_i$  last dorsal  $n_i$ ;  $b_i$  latissimus dorsal  $m_i$ ;  $c_i$ , serratus post. inferior  $m_i$ ;  $d_i$  middle layer of lumbar fascia;  $e_i$  outer layer;  $f_i$  ext. oblique  $m_i$ ;  $g_i$  int. oblique  $m_i$ ;  $h_i$  perinephritic (extraperitoneal) fat;  $h_i$  quadratus lumborum  $m_i$ ;  $h_i$  rector spine  $m_i$ .  $h_i$  Nephrotomy:  $h_i$  first lumbar  $h_i$ ;  $h_i$  kidney;  $h_i$  transversalis fascia.  $h_i$  Ligature of the sciatic and internal pudic arteries, and exposure of the great sciatic, small sciatic, and internal pudic nerves:  $h_i$ ,  $h_i$  gluteaus  $h_i$ ;  $h_i$  inf. gluteau  $h_i$ ;  $h_i$ ;  $h_i$  inf. gluteau  $h_i$ ;  $h_i$ ;

of ligation the inguinal canal is opened; in Abernethy's method the inguinal canal is not opened.

The Gluteal Artery.—This vessel is a continuation of the posterior division of the internal iliac. It emerges from the great sacrosciatic foramen at the upper border of the pyriformis muscle. It rests upon the glutæus minimus, divides into three branches, and is covered by the glutæus maximus muscle. The superior gluteal nerve lies inferior to the artery (Fig. 229).

Ligation.—The patient should be prone. The surgeon stands to the outer side. The incision corresponds to a line drawn from the posterior superior iliac spine to the upper border of the great trochanter (Fig. 230). Divide the skin, fascia, glutæus maximus muscle, and the fascia over the glutæus medius muscle, and retract the glutæus medius upward. Feel for the great sacro-

sciatic foramen, and at this point the artery is found above the pyriformis muscle. Clear the vessel and pass the needle from below upward (see Kocher's "Operative Surgery"). There is practically no mortality from this operation.

The Sciatic Artery. -This artery is the larger of the terminal branches of the anterior division of the internal iliac artery. It passes to the lower portion of the great sacrosciatic foramen, lying back of the internal pudic artery, and resting upon the sacral plexus of nerves and pyriformis muscle (Gray). It leaves the pelvis between the pyriformis and coccygeus muscles, and passes downward between the ischial tuberosity and great trochanter. It is covered by the glutæus maximus muscle, rests upon the gemelli, internal obturator and quadratus femoris muscles, has the great sciatic nerve external to it, and the small sciatic nerve external and posterior (Fig. 229).

Ligation.—The patient lies prone. The surgeon

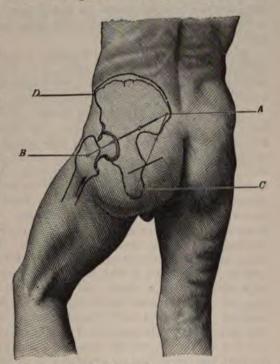


Fig. 230 .- Position and direction of the superficial incisions which must be made in order to secure the gluteal artery and the sciatic and pudic arteries: A, Posterior superior iliac spine; B, great trochanter; C, tuberosity of the ischium; D, anterior superior iliac spine; A B, iliotrochanteric line, divided into thirds. This line corresponds in direction with the fibers of the glutæus maximus muscle. The incision to reach the gluteal artery is indicated by the darker portion of the line. Its center is at the junction of the upper and middle thirds of the iliotrochanteric line, and exactly corresponds with the point of emergence of the gluteal artery from the great sciatic notch. A C, ilio-ischiatic line. The incision to reach the sciatic artery and internal pudic is indicated by the lower dark line. It is also to be made in the direction of the fibers of the glutæus maximus muscle. The center of the wound corresponds to the junction of the lower with the middle third of the ilioischiatic line (MacCormac).

stands to the outer side. The incision "corresponds to the middle twothirds of a line extending from the posterior inferior iliac spine to the base of the great trochanter."\* MacCormac advises the incision shown in Fig. 230). Divide the skin, fat, fascia, and the glutaus maximus muscle. Find the artery at the lower border of the pyriformis muscle and trace it to its point of emergence from the pelvis. Pass the ligature from without

inward. There is practically no mortality from this operation.

Internal Pudic Artery.—This artery is one of the terminal branches of the anterior trunk of the internal iliac. It passes to the lower margin of the great sacrosciatic foramen, and leaves the pelvis between the pyriformis and coccygeus muscles, crosses the ischial spine, and again enters the pelvis by the lesser sacrosciatic foramen. The vessel is accompanied by the internal pudic nerve (Fig. 220).

Ligation.—The position of the patient and the incision are the same as for ligation of the sciatic artery (Fig. 230). The artery is found below the ischial spine. Pass the needle from below upward to avoid the nerve. There

is practically no mortality from this operation.

Ligation of the Abdominal Aorta.—This operation was first performed by Sir Astley Cooper in 1817. The patient lived but a few hours. Fifteen cases of ligation of the aorta have been published, and there were 15 deaths, but only 4 of these cases were aseptic operations. The patient of Monteiro, of Rio Janeiro, lived for ten days. The circulation was entirely restored in the limbs, and the man died from hemorrhage resulting from the ulceration produced by a septic ligature. Keen's case lived for forty-eight days after ligation just below the diaphragm. The urinary secretion was plentiful and the circulation in the lower extremities was restored, death resulting from cutting through of the ligature. Robt. T. Morris performed distal ligation below an aneurysm. He encircled the aorta with a soft-rubber catheter and clamped it with forceps. Twenty-two hours after operation the aneurysm began to shrink, and in three hours more had apparently disappeared. Twenty-seven hours after operation the clamp and catheter were removed. The patient died of septicemia fifty-three hours after operation. The necropsy disclosed gangrene of a bit of intestine which had been in contact with the forceps, but the dissecting aneurysm was filled with solid clot, the aorta was patent, and the circulation in the extremities was re-established ("Amer. Jour. of Med. Sciences," Sept., 1900). These cases prove that under certain circumstances the operation is feasible, and in desperate cases it must be considered as a possible means of treatment.

Murray Operation.—This procedure aims to avoid opening the peritoneum. An incision is made from just below the tip of the tenth rib to a point one inch internal to the anterior superior iliac spine. The peritoneum is separated from the abdominal wall until the vessel is reached. Cooper's operation by

abdominal section is the preferable procedure.

Operation by Abdominal Section (Cooper's Operation); Instruments Required.—Those used in any ligation, with the addition of an aneurysm needle with a large curve and a very long handle. With an ordinary instrument it is extremely difficult to pass the ligature. It would be a great advantage to use an instrument which, after being passed under the vessel, could have a central eyed shaft projected, as is the center shaft of a Bellocq cannula. Floss silk is probably the best ligature material.

If the patient is much exhausted, an assistant should infuse salt solution in a vein during the operation. In Keen's case there was profound shock, but the moment the ligature was tightened it passed away.

Operation.—The patient should be placed upon his back. The surgeon

stands to the right of the patient and opens the abdomen in the median line, a little above the level of the aneurysm. The intestines are packed aside, the posterior layer of the peritoneum is divided, the surface of the aorta over a small area is cleared of nerves, the plexuses being separated with a blunt dissector.

The needle is passed from right to left. A double ligature of floss silk should be passed and the ends should be tied with a stay-knot. The wound is closed and dressed.

It has been suggested—I think by Wyeth—that it might be wise to only partially tighten the ligature at first, completing the occlusion of the artery after a day or two. Such a procedure would certainly give a better chance for the collaterals to dilate, and restore circulation in the legs.

Unfortunately, in an aneurysm, the vessel will usually be extensively diseased, and ligation will be out of the question. If, however, a normal region is found, the chance of success in a case of aneurysm will be greater than in a case of hemorrhage from a branch of the aorta, because, in a case of aneurysm, the probabilities are that the collaterals are somewhat distended before a ligature is applied.

## XIX. DISEASES AND INJURIES OF BONES AND JOINTS.

DISEASES OF THE BONES.

Atrophy of bone is a diminution in the amount of bony matter without change in osseous structure. It arises from want of use (as seen in the wasting of the bone of a stump) or from pressure (as seen in the destruction of the sternum by an aneurysm of the aorta). Eccentric atrophy is the thinning of a long bone from within, the outer surface being unchanged. It is usually a senile change. Concentric atrophy means a thinning of the outer surface of the shaft, causing a lessened diameter. It is usually linked with eccentric atrophy.

Hypertrophy of bone may be due to increased blood-supply (as is seen in chronic epiphyseal inflammation), the bone growing much more than does its fellow. It may arise from excessive use or from strain, as is seen in

the increased size of the fibula when the tibia is congenitally absent.

Tumors of Bone.—Bones give origin to both innocent and malignant tumors. Myeloid sarcoma takes origin in the endosteum and expands the bone. The fasciculated sarcoma is a periosteal growth. Besides these growths there may develop an osteoma, a chondroma, and secondary deposits of cancer and sarcoma. There is no such thing as primary cancer of bone. A bone may become cystic, and occasionally the cysts are due to hydatids. Gummata are frequently met with.

Cysts and Cystomata of Bone.—One variety of cyst is found in the jaws (dentigerous cysts, page 355). The other variety occurs usually in the medullary canal of long bones and very seldom in short bones and flat bones. "It differs from the dentigerous cyst in the absence of a connective-tissue capsule. The fluid is usually hemorrhagic. Islands of cartilage may be found in the bone capsule" (Bloodgood, in "Progressive Medicine," Dec. 1, 1997).

A bone-cyst slowly expands and thins the shaft of the bone, and in some cases fracture of the bone is the first evidence of the trouble. Union takes place after fracture, but the enlargement remains. The x-ray picture does not enable us to make the diagnosis, because it exactly resembles the picture of any medullary growth possessed of a bony capsule and producing osseous absorption.

The diagnosis is proved by exploratory incision and the condition is treated by curettement and drainage.

Many bone-cysts are produced by softening of solid neoplasms (sarcoma, myxoma, medullary fibroma, chondroma). Occasionally cysts form in osteomalacia and osteitis deformans, the condition arising from softening. Hydatid cysts and dermoid cysts are sometimes encountered. A true cystoma of bone, except in one of the jaws, is a surgical rarity. In the jaws cystomata are not very uncommon.

Syphilis of bone (see page 322).

Actinomycosis of bone is most usual in the jaw, but may attack the orbit, ribs, sternum, or limbs (see page 309). Actinomycosis of bone may

arise secondarily after infection of superficial parts with the ray-fungus. In the jaw the fungus obtains entrance to the interior of the bone through a tooth socket. In some cases of bone actinomycosis the fungus reaches the bone by the blood. Actinomycosis leads to the production of granulation tissue, the bone is expanded and becomes carious, and a quantity of new bone is sometimes produced. In vertebral actinomycosis, although the condition resembles tuberculosis, angular deformity does not occur.

Tuberculosis of bone (tuberculous osteomyelitis) tends especially to appear in the cancellous ends of long bones. In about one-fifth of the cases it is primary, that is, only one focus can be found. In such cases the point of entry shows no lesion, or the lesion at that point may have healed. In some cases the bacilli enters through the tissue. Trauma may be an exciting cause. Long after apparent healing the disease process may awaken into activity and trauma is often the cause of the awakening (König). In one of König's cases trouble began anew after sixty years. The disease is especially apt to attack the epiphysis and spread to the joint, although in some cases it spreads to the shaft. Primary tuberculosis is rare in the shafts of long bones, but is not uncommon in the shafts of short bones. A bone focus leads to the formation of a bone cavity which may contain tuberculous granulations or bone sequestra. The sequestra in tuberculous osteomyelitis are not completely loose, but are still attached at some point. The bone may sclerose or may undergo alterations of an osteoporotic nature, making it soft. Sclerotic bone means a healing process. Softened bone means a spreading process. A sequestrum in tuberculous osteomyelitis is usually wedge-shaped, the base being toward the joint. A sequestrum is due, König thinks, to the obstruction of a terminal artery by a tuberculous embolus or by the intra-arterial growth of bacilli ("Die Tuberculose der Menschlichen Gelenke, swiel der Brustwand und des Schaedels"). In a certain number of cases tuberculosis infiltrates a spongy bone with great rapidity because of rapid caseation. This condition is known as infiltrating progressive bone tuberculosis (see page 252).

Osteitis, Periostitis, and Osteoperiostitis.—Osteitis, or inflammation of bone, may be due to traumatism, to a constitutional malady or diathesis, to the extension of inflammation from some other structure, to certain fevers, to cold, to phosphorus or mercury, to infection, or to working in pearl button factories. In inflammation of bone the exudate and leukocytes pass into the Haversian canals, spaces, and canaliculi. The bone corpuscles proliferate and the bone undergoes thinning (rarefaction), not because of pressure, but because of absorption by voracious leukocytes and osteoclasts. This process of rarefaction enlarges all the bony spaces, and by destroying septa throws many of the spaces into one. If the surface of a bone inflames, the periosteum will be separated more or less by exudation, and the bone will be covered with little pits or erosions made by the leukocytes. Inflamed bone is so soft that it can readily be cut with a knife.

Pearl workers' osteitis occurs particularly in youths before fusion of the epiphyses. It arises in the diaphysis by the epiphysis. The bones of the limbs are most apt to suffer, but the bones of the face or chest may be attacked. The attack begins with pain and moderately elevated temperature and the fever may persist for several weeks. The condition may apparently get well

and yet begin again when the patient returns to work. The lesions are often symmetric and always multiple (Broca). It is a condensing osteitis and undergoes spontaneous cure if the patient gives up the occupation (Deturk, in "Archives Générales de Chirurgie," Nov., 1908).

Osteitis may terminate in resolution or it may terminate in sclerosis, the mass of proliferating cells being converted first into fibrous tissue and next into dense bone which contains a very few small cancellous spaces. If the exudation is under the periosteum, the bone will be thickened at this point, bone stalactites marking the points of passage of the vessels. Osteitis may terminate in suppuration, this condition being often called caries. In tuberculous osteitis caseation of the inflammatory products is very apt to arise (tuberculous caries, the strumous caries of our predecessors). Acute osteitis may terminate in necrosis, the inflammatory exudate compressing the vessels in their bony canals, a portion of the bone being, in consequence, deprived of nutritive material. The portion cut off from nutritive fluid dies en masse (necrosis). Osteitis is usually associated with more or less periostitis. A simple acute periostitis without involvement of the bone may arise from traumatism or strain; but in all severe cases of periostitis, in all chronic cases, in all cases due to syphilis, rheumatism, measles, scarlatina, or enteric fever the bone is involved at the same time or subsequently. In syphilitic states gummatous degeneration frequently ensues.

Symptoms of Osteitis and Osteoperiostitis.—As a chronic process, osteitis is most commonly found in the femur. Its history usually exhibits a record of an antecedent injury or chilling of the body. Pain is severe, boring or aching in character, deep-seated, worse at night, and aggravated by a dependent position of the part. The symptoms closely resemble those of periostitis, with which disease it is almost sure to be linked. Tenderness exists on percussion, and sometimes on pressure. Subperiosteal swelling, fusiform in shape, is noted; cutaneous edema and discoloration are observed if a superficial bone is inflamed. In syphilis, atrophic osteitis may attack the cranial bones and produce softening or even perforation, or osteophytic osteitis may arise, exostoses being formed. Osteoperiostitis may be acute or chronic, circumscribed, or diffused, and may terminate in resolution, organization, or suppuration. It arises from cold, blows, wounds, strains, the spread of adjacent inflammation, specific febrile maladies, pyogenic infection, syphilis, rheumatism, or tuberculosis. The symptoms are pain (which is worse at night and which is aggravated by motion, pressure, or a dependent position), swelling, edema, and discoloration of the soft parts. Pain in the syphilitic form is not so severe as in other varieties. Acute necrosis or diffuse periostilis, a pyogenic inflammation of bone and periosteum, is commonest in boys about the age of puberty. It is usually due to cold, a specific fever, or injury, and most often affects the tibia or femur; the symptoms locally are redness, swelling, and severe pain; constitutionally there are rigors, fever, and sometimes convulsions. Necrosis is apt to result. Pyemia is common. In simple acute periostitis a swelling is felt upon the osseous surface. The swelling is firmly fixed and is very tender, but the bone itself is not enlarged. There is some local heat, discoloration, often fever, and the patient complains of an aching pain, which is worse at night.

Periostitis due to strain demands some special attention. Sir James Paget, years ago, pointed out that muscular exertion might cause periostitis. C. T. Dent has written a valuable article upon this subject.\*

It is common to hear football players complain of some swelling of the knee-joint. Examination finds tenderness over the tubercle of the tibia with slight swelling of the joint. Dent points out that pain is felt on straightening the leg, not on rotating it. The same observer states that omnibus drivers suffer from periostitis of the fibula, due to pressing forcibly against the footboard; those who ride may develop periostitis of the adductor insertion (riders' bone); the victims of flat-foot may labor under periostitis of the inner tuberosity of the os calcis; bar-keepers, from working a beer-pump, may get periostitis of the scapula, pain being marked on contracting the biceps; a housemaid may develop periostitis at the points of bony origin of the great pectoral from the chest, the condition being due to sweeping and scrubbing.†

Treatment of Osteitis and Osteoperiostitis.—In syphilitic forms the local treatment consists in rest, elevation of the part, the application of iodin and mercurial ointment, and bandaging. Specific treatment is by the stomach or hypodermatically. Operation is rarely justifiable. In other forms, if the case be recent and severe, put the patient to bed, place the limb in a splint and elevate it, employ cold, apply a bandage, and give salines and iodid of potassium internally. Later use ichthyol inunctions locally and apply a hot water-bag. Morphin is administered for pain. If these means fail, order counterirritation by iodin and blue ointment or blisters, and apply heat locally. In severe cases take a tenotome and slit the periosteum subcutaneously to relieve tension; this procedure often quickly relieves the pain. Some cases demand a longitudinal osteotomy, which is performed by taking Hey's saw and dividing the bone longitudinally into the medullary canal. If pus forms, drain at once.

Diffuse osteoperiostitis requires early and free incisions, antiseptic irrigation, drainage, rest and elevation of the limb, and strong supporting and stimulating treatment. Amputation is sometimes demanded, as when the patient grows weaker and weaker even after incision, and when a joint is seriously involved. If the necrosis affects the entire shaft, which separates from its epiphyses, and new bone has not yet formed from the periosteum, make a subperiosteal resection of the shaft.

Chronic periostitis is usually syphilitic. A node is a chronic inflammation of the deep periosteal layers. Nodes occurring early in the secondary stage remain soft and soon pass away under treatment, but those occurring two years or more after infection are apt to cause a bony deposit. A node may soften, leaving a sinus, at the bottom of which is a piece of dead bone. Gumma of the periosteum is one form of node which is apt to produce caries

Osteoplastic periostitis accompanies chronic osteitis and causes the deposit of new bone, which undergoes sclerosis. The chief symptom is aching pain, which is worse when the patient is warm in bed, and is aggravated by damp and wet. A swelling is found at the seat of pain (often over the tibia

ulna, clavicle, or sternum). The soft parts are uninflamed and move freely unless softening or suppuration has occurred. Tenderness is manifest.

Treatment of Chronic Periostitis and Osteoplastic Periostitis.—For the nodes of early syphilis administer mercury by the plan usually followed in secondary syphilis; for the nodes of late syphilis give mercury and large advancing doses of iodid of potassium. Blisters, blue ointment, and iodin are applied to the skin over the area of periostitis in both forms, and subcutaneous division of the periosteum is of value. If suppuration occurs, incise antiseptically.

Chronic Abscess of Bone, or Brodie's Abscess.—This condition is sometimes due primarily to tuberculous infection, symptoms being absent for a longer or shorter time and arising because of secondary infection with staphylococci. It is always chronic, never acute. A very acute inflammation, such as is induced by virulent pyogenic organisms, causes acute necrosis rather than an acute abscess. After typhoid fever an area of suppuration may slowly form in the head of a long bone, due to the action of typhoid bacilli. Non-virulent staphylococci may be responsible, and the condition may follow long after a



Fig. 231.—Chronic abscess in the great trochanter ("American Text-Book of Surgery").

staphylococcus osteomyelitis, and in 84 per cent. of cases of Brodie's abscess this is the history (Alexis Thomson). The same author says the latest period between the osteomyelitis and the abscess varies from one to fifty-seven years. Chronic abscess of bone was first described by Sir Benjamin Brodie, and is often called Brodie's abscess. It occurs in the cancellous structure of the ends of bonesusually in the head of the tibia, sometimes in the femur (Fig. 231) or humerus. It seldom occurs in the shaft of a long bone. A tuberculous abscess of bone may follow a slight injury, which constitutes a point of least resistance. Bacteria lodge and multiply; bone rarefaction leads to the formation of a cavity, the inflammatory products caseate, sometimes sup-

puration arises, and the surrounding bone thickens and hardens because of growth from the periosteum. The abscess is apt to break and often breaks into a joint, as the joint-surface is not covered by periosteum and no barrier of bone is there formed. Brodie's abscess may induce necrosis.

Alexis Thomson thus describes Brodie's abscess ("Edinburg Med. Jour.,"
April, 1906).

In the first or quiescent stage there is a cavity filled with serum and lined with a membrane like the periosteum of young bones. The outer layer of the membrane is forming new bone of a spongy nature, "further away the old bone is sclerosed and the medullary canal obliterated."

When the mature stage or abscess stage arises the lining membrane is converted into granulation-tissue, and the cavity becomes filled with staphylococcus pus. The outer layer of granulations erodes the bone and the abscess progressively enlarges. As the bone is eroded within, new bone is formed Caries 505

by the periosteum and the bone enlarges. If pus formation is more rapid than bone erosion there is tension and pain, but if bone erosion is sufficiently rapid to prevent tension there is little or no pain. Finally the abscess perforates the bony shell "on the periosteal surface or into an adjacent joint."

Symptoms.—There are attacks of boring pain, worse at night and aggrevated by motion and pressure, and a dependent position. The pain is intermittent and may be absent, for many days at a time. These pains are frequently thought to be rheumatic. The tenderness is marked, even when pain is absent, and is not in the joint, as the patient believed the pain was, but is over the abscess. If the head of the tibia or the great trochanter is the seat of disease percussion over that region develops pain most certainly. At times pain in the bone becomes excruciating and tenderness acute. There is more or less loss of function in the limb and in far advanced cases the bone is enlarged. There may be thickening of the bone and soft parts, edema and discoloration of the skin over the seat of trouble, and attack after attack of synovitis in the nearest joint. Irregular fever and sweats are usually noted but there may be no fever. The harrassing pain causes sleeplessness, exhaustion, and emaciation. When the pus breaks through the bone abscess develops in the soft part, and if this bursts or is opened pain ceases (Thomson). In many cases the x-rays aid in making the diagnosis.

Treatment.—In treating bone-abscess, trephine the bone at the point of greatest tenderness, and if the abscess is missed, follow the advice of Holmes and perforate the wall of bone with the trephine, opening in several directions to discover the tuberculous matter or pus. It is often easy to open into the abscess with a chisel or gouge. After opening the cavity scrape its walls, remove dead bone, thoroughly dry with gauze, touch with pure carbolic acid, and pack with iodoform gauze. If the abscess opens into a joint, trephine the

bone and open, irrigate, and drain the joint.

Caries was a term once used universally to signify suppuration or molecular death of bone. In some cases caries means suppurative osteitis; in others, tuberculous osteitis; in still others, gummatous osteitis. Typhoid fever is occasionally followed by a carious condition of bone. Osteitis is apt to become purulent when the bone is exposed to the air, when rest is not secured, when the health of the individual is below normal, when a foreign body such as a bullet is in the bone, or when tubercle or syphilis exists. The term is seldom used to-day except loosely, and then usually to signify tuberculous disease of bone. When caries arises, the softened and granulating bone breaks down and is discharged through a sinus. After drainage is secured organization, sclerosis, and healing may result. In these cases new bone may form and a cure follow.

Tuberculous or strumous caries (caseous osteitis), a condition produced by the caseation of the products of a tuberculous osteitis, shows no tendency to self-cure, no organization or sclerosis take place, and new bone seldom forms unless an operation is performed. The interior of bones, especially of the carpus and tarsus, is entirely softened and destroyed and thin shells only are left.

Caries necrotica is a condition in which small but visible portions of soft and dead bone are cast off; caries sicca is molecular death of bone without liquefaction or suppuration.

The caseating masses in tuberculous caries contain tubercle bacilli.

If a tuberculous collection is evacuated and infection with pus organisms occurs, genuine suppuration takes place, and constitutional infection causes septic fever and may cause death. Pyogenic osteitis may affect any part of any bone; but caseous osteitis (tuberculous caries) tends to arise especially in cancellous structures (heads of long bones, vertebral bodies, ribs and sternum, and bones of the carpus and tarsus). Tuberculous osteitis of the shaft of a long bone occasionally, but rarely, arises. Tuberculous osteitis is apt to cause tuberculous disease in an adjacent joint. Tuberculous osteitis

may be followed by the formation of a cold abscess.

Symptoms.—In the beginning the evidences of caries are usually those of osteitis, but the first sign noted may be a fluctuating swelling due to pus or to caseated tubercle. After a time, at any rate, a fluctuating swelling is discovered. If not opened, the softened mass breaks externally, voids its contents, and leaves a sinus from which flows caseated matter which after a time becomes thin, reddish, and irritating to the skin, contains small portions of gritty bone, and has a foul smell. The opening of the sinus fills up with edematous granulations. A probe carried to the bottom of the sinus finds bone which is sieve-like (worm-eaten), and which on being struck gives a muffled note rather than the clear, sharp note of necrosis; the bone is rough, is bared, and is so soft that the probe can usually be stuck into it. In old

cases of caries amyloid disease may arise.

Treatment.—If syphilis exists, give iodid of potassium in advancing doses and a mild mercurial course. If tuberculosis exists, give iodid of iron, arsenic, cod-liver oil, and nourishing foods, and recommend ocean air and living in the open air. Locally, in all cases, insist on rest and at once secure drainage, enlarging the opening, if necessary, and inserting a tube, and even making additional openings; syringe often with antiseptic fluids and dress antiseptically. If the case is seen before spontaneous evacuation has occurred, open under strict antiseptic precautions. When a chronic sinus exists there arises the question of operation. Incomplete operations are worse than useless, for they may be followed by diffuse tuberculosis or pyemia. If the gouge is used, try to remove all carious bone. The diseased bone is white, crumbles, and does not bleed; the non-carious bone is pink and vascular. Scrape away all granulations, swab the cavity with pure carbolic acid, and pack it with iodoform gauze. Instead of gouging away bone, there may be used the actual cautery, sulphuric acid, or hydrochloric acid. In severe cases excision is required, and in some rare cases amputation may be necessary. Caries of the spine is considered under Diseases of the Spine.

Necrosis is the death of visible portions of bone from circulatory impediment or the direct action of bacterial toxins. It is analogous to gangrene. One cause of necrosis is traumatism (such as the tearing off of periosteum) which deprives the bone of blood. Inflammation of the periosteum further lessens the nutrition. Acute inflammation in bone causes necrosis, the excessive exudation in the canals and spaces occluding the blood-vessels by pressure. The occlusion of vessels by bacterial thrombi or emboli may lead to necrosis, or the direct action of toxins may first inflame and finally destroy a portion of the bone. A thin shell of bone only may necrose from periosteal separation, or an entire shaft may die from acute pyogenic osteomyelitis or diffuse infective periostitis. Osteomyelitis is the most usual cause of necrosis. Necrosis is most frequently met with in

the diaphyses of the long bones, caries in the cancellous tissue of bones. The ribs may become carious, but very rarely become necrotic. A sequestrum may, but does not often, form in a vertebral body in the cancellous head of a long bone, in the carpus, or in the tarsus. If a sequestrum arises from tuberculous osteomyelitis it is seldom completely detached, but still retains some vascular connection. In tuberculous osteomyelitis of a long bone the sequestrum is wedge-shaped with its base toward the joint, and is due to infarction of terminal arteries. A fragment of dead bone is a foreign body; the healthy bone adjacent to it inflames and softens; granulations form, and this line of granulation, like the line of demarcation of gangrene, tends to separate the dead part from the living, the white dead bone being surrounded by the red zone of granulation tissue. A bit of dead bone is called a "sequestrum," and Nature tries to cast it off. A superficial sequestrum is known as an "exploiation."

Nature's method of casting off a sequestrum is as follows: suppuration takes place at the line of demarcation, osteitis extends for a considerable distance around this line, the periosteum shares in the inflammation, and new bone forms. A cavity is thus made within by suppuration, and a box or case forms without by ossification, the now entirely loosened sequestrum being so encased that it cannot escape. The pus finds its way through the

new bone, and there is presented the condition so often seen by the surgeon—namely, a case of new bone known as the "involucrum," a cavity containing pus and the dead fragment or sequestrum, and a discharging sinus or "cloaca" (Fig. 232). Nature may eventually cast off the fragment, but the surgeon should not wait for the completion of this slow process.

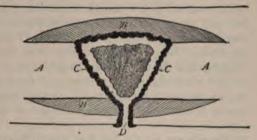


Fig. 232.—Diagram illustrating the formation of a sequestrum: A, Sound bone; B, new bone; C, granulations lining involucrum; D, cloaca; E, sequestrum.

When a portion of the bone surrounding the medullary canal dies, the condition is called "central necrosis." In some rare cases necrosis occurs without apparent suppuration, a painless swelling of bone simulating sarcoma. This condition is known as quiet necrosis, and has been described by Sir James Paget and Mr. Morrant Baker. Mercury is an occasional cause of necrosis. The fumes of phosphorus may cause necrosis of the lower jaw in those with decayed teeth. Necrosis may be produced also by frost-bites and burns. Many fevers (measles, typhoid, scarlet fever, etc.) are occasionally followed by necrosis. Syphilis and tuberculosis are occasional causes.

Symptoms.—The symptoms of necrosis are at first those of osteitis or osteomyelitis. The abscess, when formed, opens of itself or is opened by the surgeon, and a sinus or sinuses form in the soft parts as happens in caries. A probe introduced into the sinus strikes upon hard bone with a clear, ringing note, and often finds a sinus or sinuses in the bone. In superficial necrosis the discharge is slight and the probe shows the limitations of the disease. In extensive necrosis the discharge is profuse, much new bone forms, several sinuses appear far apart, and the probe must pass through a considerable

thickness of new bone before it finds the bit of dead bone. The surgeon should not operate until the dead bone is separated from the living by a line of demarcation, and until the sequestrum is loose. In youth dead bone loosens quickly, but in old age slowly. An exfoliation becomes loose sooner than the sequestrum of central necrosis. In diffuse periostitis the necrosed shaft loosens quickly. Necrosed portions of the upper extremity loosen more rapidly than those of the lower. In a young adult two or three months will be required to loosen a necrosed fragment in the lower extremity and from six weeks to two months in the upper. A loose sequestrum may be moved by the probe, and when struck gives a hollow note. In protracted cases of necrosis there is always danger that amyloid disease may arise.

Quiet necrosis is a rare condition which has led to some deplorable but pardonable mistakes, because it resembles ossifying sarcoma. It follows injury, particularly fracture. The bone enlarges greatly. There is little or no pain and no fever. The diagnosis can only be made by exploratory incision, and it may even be necessary to remove portions for microscopic study before a conclusion can be reached.

Post/ebrile necrosis is most usually met with after typhoid fever. The bacilli of typhoid cause chronic osteomyelitis, and this is followed by necrosis. Scarlet fever, measles, and other febrile processes may also induce necrosis. It is certain that bacilli accumulate in the bones during typhoid fever. They may promptly induce disease; they may remain for long periods apparently inactive and finally pass away; or after a slight strain or injury these organisms may induce bone disease months or even years after the primary infection. Typhoid bone disease is often multiple, many bones being involved successively.\* Not unusually after typhoid fever muscle strain causes periostitis and osteitis, and at such a point necrosis may occur. Either exfoliation or central necrosis may follow typhoid fever. The tibia is involved more often than other bones.

Treatment.—An exfoliation should be removed as soon as it becomes loose, the seat of trouble should be touched with pure carbolic acid, and packing of iodoform gauze should be inserted. The treatment of central necrosis comprises free incisions for drainage, antiseptic dressing, frequent cleansing, rest, nourishing food, stimulants, and tonics. When the sequestrum becomes loose the operation of sequestrectomy or necrotomy is performed, the extremity is drained of blood, an Esmarch band is applied, the bone is exposed by a longitudinal incision, the periosteum is reflected on each side, and the involucrum is broken through and the opening is enlarged with the chisel, gouge, and rongeur. The dead bone should be removed by sequestrum forceps, the cavity scraped by a sharp spoon, the lateral edges of the involucrum cut down until the cavity which formerly contained the sequestrum is very shallow, the wound is irrigated with hot salt solution, dried, painted with pure carbolic acid and then with alcohol, again irrigated with salt solution, and firmly packed with iodoform gauze. Remove the Esmarch band, tie the vessels in the soft parts, suture the wound, and apply dressings. The simple removal of a sequestrum -i. e., the operation of sequestrectomy-often fails to effect a cure, and even in the most satisfactory cases healing requires a very long time. "The in-

<sup>\*</sup>Keen's "Surgical Complications of Typhoid Fever."

volucrum always contains pyogenic germs that may live in its small foramina and crevices almost indefinitely. For this reason, and on account of the denseness of bony structure, it is well-nigh impossible to disinfect it" (Dr. J. Shelton Horsley, in the "Medical Record," Oct. 20, 1900). Because of the difficulty of curing a case when an involucrum has formed, Dr. Cushing, of Baltimore, has warmly advocated early operation in osteomyelitis; that is, operation before an involucrum has formed, and when the osteoblasts of the periosteum are extremely active. He points out that if an involucrum has formed, the sequestrum and involucrum should be removed after stripping the periosteum from this region. If the periosteum is found not to be infected, it may be stitched together at the gap where the bone has been removed, so that a periosteal cord exists between the two ends of the bone; and the soft parts above this may be closed. If the periosteum is found to be infected, we agree with Cushing that the cavity should be packed with gauze. The cavity that is left by the removal of a sequestrum and the chiseling of the walls of the involucrum, if large, may be filled by various methods more or less satisfactory. In some cases of widespread necrosis due to diffuse infective osteoperiostitis or to osteomyelitis, extensive resection, or even amputation, may be

Treatment of Bone Cavities .- Schede does not pack the bone-cavity but allows it to fill up with blood-clot after the wound in the soft parts has been closed with sutures. The blood-clot obliterates the dead space in the bone, acts as a support for granulations from the margin, and is slowly eaten up. Unfortunately it is an excellent culture-medium and it often fails of its purpose. The surgeon may try to fill the cavity by taking flaps of skin from the sides of the wound, separating them freely from the fascia beneath and holding them within the bone cavity by inversion sutures or fastening them to the bottom with nails (Neuber's operation). Another operation consists in breaking the edges of the involucrum and turning them in. Some surgeons insert decalcified bone-chips. Bone-chips are prepared as described on page 78, and they are applied as is directed below. The cavity in the bone is made sterile and is well dusted with iodoform, the bone-chips are dried and inserted into the cavity, a capillary drain is employed, the periosteum is stitched over the opening, and the soft parts are sutured; but if this cannot be done, iodoform packing is used to keep the chips in place. This method we owe to the genius of Senn. Senn's method often fails because of the impossibility of completely sterilizing the walls of the bone-cavity. Attempts have been made to fill bone-cavities as a dentist fills teeth-with guttapercha, plaster-of-Paris, copper amalgam, etc., but each of these materials acts as a foreign body in the bone (James E. Moore, on "the Treatment of Bone-cavities," "Jour. Am. Med. Assoc.," May 20, 1905). Schleich uses formalin-gelatin to fill bone-cavities. The difficulty in every case is the impossibility of completely sterilizing the walls of the cavity. Dressman has advised for this purpose the use of boiling oil, but it is apt to cause superficial necrosis. In some cases the cavity has been healed by the insertion of a Thiersch skin-graft. This method has been advocated by J. P. Lord ("Jour. Am. Med. Assoc.," May 31, 1902). Von Mosetig-Moorhof's method is one of the best (Zeitschrift für Chirurgie," lxxi, No. 5). He pours into the cavity a melted material which completely fills the cavity, which will not act as a culture-medium or as a foreign body, which is gradually absorbed, and which "possesses the inhibitory and medicinal properties of iodoform without causing iodoform intoxication" (James E. Moore, on "The Treatment of Bone-cavities," "Jour. Am. Med. Assoc.," May 20, 1905). Mosetig's material consists of 60 parts of iodoform, 40 parts of spermaceti, and 40 parts of oil of sesame. These materials are mixed by heating gradually up to 100° C. On cooling, a solid mass is formed. When the surgeon wishes to use it he heats it up to 50° C. and stirs it while heating (Moore), and pours it into the cavity in the bone. On entering the cavity it at once solidifies. A capillary drain is introduced, the periosteum is sutured with catgut, and the skin is sutured with silkworm-gut. Many attempts have been made to fill the defect by bone-grafting. The first case of satisfactory transplantation from one of the lower animals with the retention of a vascular attachment was reported by A. W. Morton in "American Medicine," July 12, 1902. The patient suffered from a compound comminuted fracture of both bones of the right leg. The fracture in the fibula united, but the tibia underwent necrosis, and it was necessary to remove five inches of the lower end of the bone. Some days later, the periosteum was raised from the ends of the bone and these ends were freshened. The left leg of a dog was amputated just above the tarsus, the bones being sawed so that the ulna was one inch longer than the radius. The lower end was partly bared of periosteum, and the ulna of the dog was forced into the cavity of the tibia of the man, and wired to that bone with silver wire. The incision in the man's leg was then sutured, and powerful tendons in each leg of the dog were divided. Each of the dog's other legs was wrapped separately in a plaster-of-Paris bandage, and the entire animal and the leg of the man were then put up in a plaster-of-Paris dressing. Five weeks later the cast was removed, and the bones were sawed and placed in contact with the astragalus. Union took place, and the man was fortunate enough to obtain a useful leg. In some cases a bone defect may be supplied by transference of another bone. Nichols reported 11 cases and insisted on the necessity of preserving the periosteum ("Jour. Am. Med. Assoc.," Feb. 3, 1904). Huntington has reported a case similar to case No. 2 in Nichols' list. The patient was a boy of seven. A large piece of the entire thickness of the tibia was lost as a result of acute osteomyelitis. There was a gap of 5 inches between the ends of the bone, and the leg was a mere flail. Eight months after the beginning of the osteomyelitis the fibula was sawed opposite the lower end of the upper fragment of the tibia and the upper end of the lower fragment of the fibula was fixed in a cup-shaped depression in the lower end of the upper fragment of the tibia. Six months later union was solid, but in order to improve the weight-bearing power of the limb, nine months after the first operation, the lower end of the upper fragment of fibula was fastened to the upper end of the lower fragment of tibia. The result was excellent. The shortening is only three-fourths of an inch ("Annals of Surgery," Feb., 1905).

Acute pyogenic osteomyelitis is an acute and diffuse inflammation of the bone-marrow due to pyogenic organisms. Infection from staphylococci may be limited to a portion of one bone. Streptococcus infection causes widespread involvement of a bone or of several bones. Acute osteomyelitis may be due to

mixed infection with bacilli of typhoid and pyogenic organisms, or bacilli of tubercle and pyogenic organisms, a typhoid process or a tuberculous process serving to establish a point of least resistance. The gonococcus and the pneumococcus occasionally produce acute osteomyelitis. In a case of gonor-theal arthritis in which I resected the wrist-joint cultures of gonococci were obtained from the interior of the bone removed.

It was at one time believed that osteomyelitis was due to a specific organism, but Pasteur proved that micrococci are the cause, and Ogston demonstrated pyogenic bacteria in pus obtained from cases of osteomyelitis. In some cases there is pure staphylococcus infection (aureus or albus), both aureus and albus may be present, there may be mixed infection with streptococci and staphyloocci, streptococci and several sorts of bacilli, or staphylococci and bacilli. Mixed infections with streptococci are more malignant than staphylococcus infections. Most cases of osteomyelitis are due to staphylococci. Ullman was unable to experimentally induce osteomyelitis without first creating by bone injury a period of least resistance. When he applied a ligature to a rabbit's leg for fourteen hours distinct changes were found to occur in the marrow of the bones. These changes consisted chiefly in extravasation and localized hemorrhages. When the marrow was in this condition, if virus were injected into the animal, osteomyelitis resulted, because the bones presented points of least resistance, vulnerable points in which pus cocci lodged and multiplied.

The pyogenic organisms may gain entrance directly by way of a wound (a gunshot-wound, a compound fracture, an amputation). The causative organisms may reach the bone by way of the blood, having entered the blood originally through the lymphatic system or from a focus of suppuration in

the skin, the subcutaneous tissue, or a deeper part.

Pus organisms may pass into the blood from the tonsils or respiratory organs (Kraske); the intestinal canal (Kocher); the genito-urinary tract; or from excoriations, bruises, or small wounds in the skin (Warren). Certain fevers strongly predispose to the disease by preparing the soil as it were for the growth of pyogenic bacteria. Typhus fever, smallpox, malarial fever, scarlet fever, measles, and diphtheria lessen the vital resistance of bonemarrow. Typhoid fever is not unusually followed by a chronic osteomyelitis, due solely to typhoid bacilli. If mixed infection with pus organisms occurs, acute osteomyelitis arises. Vital resistance of marrow is lessened by exhausting diseases, overexertion, unhealthy and especially putrid food. We know that various infections produce various reactions in marrow, and in this changed marrow vital resistance is probably lessened or even seriously impaired. Longcope made a study of the marrow in 26 fatal cases of enteric fever, and he invariably found numerous lymphoid cells, phagocytes of large size, and multiple foci of distinct necrosis. The cells whose function is to form blood were noted to be undergoing hyperplasia. In those dead of perforation and general peritonitis there were numerous foci of necrosis, and also widespread degenerative changes in the blood-making cells and pronounced edema and congestion of the marrow ("A Text-Book of Pathology," by Alfred Stengel). When organisms gain entrance directly by a wound (as in a compound fracture), the endosteum, the medulla, and the cancellous tissue inflame and

suppurate, and the entire length and thickness of the bone may be involved. The periosteum becomes infiltrated, detached from the bone, and retracted from the edges of the wound in the bone. The soft tissues around the bone may inflame, suppurate, or slough. More or less necrosis inevitably occurs.

Acute osteomyelitis without a wound is often called acute epiphysitis or acute injuntile arthritis. This condition is most common in infants or children of one or two years of age, but occasionally arises in older children (from ten to fourteen years) or even in adults. It is most common during the period of active growth of bone. It is frequently preceded by one of the predisposing causes before mentioned. In many cases a strain or bruise is followed by pyogenic infection, because the damaged tissue extends a hospitable welcome to micro-organisms which are traveling in the body-fluids and pass through the injured area. In some cases chilling of the surface of the body is a predisposing cause. In others no predisposing cause is discoverable.

The compact bone suffers secondarily, but is never attacked primarily. New tissue is more susceptible to infection than old tissue, and the disease, as a rule, begins near the epiphyseal line, where new bone is being formed. This point was spoken of by Ollier as "the zone of election of pathological processes." Warren points out that in a growing bone near the epiphyseal cartilage there exists a newly formed spongy tissue, very vascular and connected with the cartilage by a spongy layer of tissue, which is not yet bone. but which does not possess a cartilaginous structure. It is in this portion of the skeleton that the most active changes take place during the period of growth. The medullary substance is very vascular at this point; it is red and without fatty tissue. It communicates with the medullary canal and with the periosteum by a number of vascular channels. The epiphyseal cartilage itself is intimately blended with the periosteum. The diaphyseal side of the cartilage produces much more bone than is found in the epiphyseal margin. There is also an active growth of bone in the periosteum, and it is in these regions and in the medullary canal that the inflammatory process originates.\* The lower end of the femur and the upper end of the tibia are the regions most commonly attacked; but the upper end of the femur and the lower end of the tibia may suffer, and other bones may be attacked, especially the humerus, radius, ulna, and inferior maxilla. The adjacent joint not unusually becomes involved. Though the inflammation begins in the spongy tissue or medulla, it passes to the canals and spaces of the compact bone. The inflammatory exudate in the canals compresses the vessels and cuts off nutrition from certain areas. Suppuration begins, clots form in the medulla from thrombophlebitis, and the clots in the vessels of the Haversian canals become septic. A small sequestrum forms at the seat of origin of the disease, and the pus about the sequestrum is apt to empty into the medullary canal, causing diffuse osteomyelitis, or into the adjacent joint, causing suppurative inflammation of the articulation.

Marked constitutional symptoms arise from absorption of toxins (suppurative fever), and sometimes true septic infection or even pyemia arises.

Very extensive necrosis may follow osteomyelitis if the patient recovers.

Symptoms.—Osteomyelitis secondary to a wound may occur in a person

<sup>\*</sup>Warren's "Surgical Pathology."

of any age. If a wound exists,—for instance, a compound fracture,—the diagnosis is evident. The constitutional symptoms of septic absorption are positive: there is a profuse, offensive, purulent discharge containing bone-fragments and tissue-sloughs; the periosteum is red, thick, and separated; there are swelling over the bone, great tenderness, and violent boring, gnawing, or aching pain. Osteomyelitis occurring without a wound, the condition known as acute epiphysitis, occurs in the young, and particularly in children

under three years of age.

The symptoms of acute epiphysitis usually come on suddenly and especially at night, and the attack may be so acute as to cause death by systemic poisoning before a diagnosis is arrived at. The disease is generally ushered in by a chill, which is followed by septic febrile temperature. The history will sometimes contain the statement that a blow had been received, that a febrile process had existed, or that the patient had been suddenly chilled after having been overheated (sitting in a draft or in a cellar on a hot day, possibly swimming when very warm, etc.). There is violent aching pain in the bone and acute tenderness near the joint; the soft parts, which at first are healthy in appearance, after a time discolor, swell, and present distended veins, and may become glossy and edematous because pus is gathered below. An abscess sometimes reaches the surface and may break spontaneously. The neighboring joint swells, and may become filled with pus; the periosteum and the shaft are involved for a considerable distance; each epiphysis may become affected, the shaft between being comparatively uninvolved, and the epiphyses may separate, displacement and shortening taking place. This disease is often mistaken for rheumatism because of the joint-swelling, occasionally for typhoid fever because of the fever, and in some cases for erysipelas because of the redness of the skin. It gives a very grave prognosis. Sometimes an epiphysitis shows milder symptoms and is slower in progress (subacute). These cases are very often mistaken for rheumatism. But in rheumatism the joint is the part involved from the beginning, while in epiphysitis the joint is involved secondarily after obvious evidence of inflammation well clear of the articulation. Further, the symptoms of rheumatism will be rapidly improved by the use of the alkalies or the salicylates.

Treatment.—If a wound exists, apply a tourniquet, sterilize the parts, enlarge the wound, expose and curet the medullary cavity, remove loose fragments of bone, irrigate the medullary cavity with a hot solution of corrosive sublimate or hot salt solution, scrape it with bits of gauze held in the bite of a forceps, paint with pure carbolic acid, pack lightly with iodoform gauze, dress with hot antiseptic fomentations, and secure rest for the parts by splints and bandages. The constitutional treatment is the same as that for septicemia. Acute osteomyelitis without a wound is a most serious condition, rapidly progressive, apt to be quickly fatal, and requiring prompt and radical treatment. In treating it do not wait for fluctuation, but incise at once; break through the bone at one or more points with a gouge or chisel; chisel away the diseased bone, and if necessary curet the medullary canal; irrigate with hot corrosive sublimate solutions or hot salt solution; swab with pure carbolic acid; use iodoform plentifully; pack with iodoform gauze; dress with hot antiseptic fomentations; drain the joint if it is involved; employ

rest, anodynes, strong supporting treatment, and other remedies advised in septicemia. Remove dead bone subsequently when it becomes loose. Am-

putation may be required in either form of the disease.

Chronic osteomyelitis is usually linked with osteitis. It may eventuate in osteosclerosis with filling up of the medullary canal, in limited suppuration, in caseation of the cancellous tissue (Brodie's abscess), or in necrosis. A tuberculous inflammation is one form of chronic osteomyelitis (page 252). Syphilis, typhoid fever, etc., may cause it, and it can be caused by glanders, leprosy, and actinomycosis.

The typhoid bacillus under certain conditions is pyogenic, Frankel taught this some years ago, and Keen seems to prove it in his work on the Surgery of Typhoid Fever. Osteomyelitis due purely to typhoid bacilli is chronic. When the medulla contains typhoid bacilli pus infection is apt to take place, and if such a mixed infection arises acute osteomyelitis develops.

In chronic osteomyelitis there are pain, tenderness, and swelling, but no marked constitutional symptoms. In some cases the real trouble is not

identified until an abscess forms (see Necrosis).

Treatment.-If an abscess exists, at once evacuate it by incising the soft parts and chiseling the bone. Do not wait for an involucrum to form, but promptly incise, disinfect and drain. If dead bone is present it must be

Osteomalacia, or Mollities Ossium.—In this disease the bones are partly decalcified, and consequently soften and bend. Masses of new uncalcified bone-tissue are formed. Many bones are usually involved, but bones of the head are not obviously affected. It is commoner beyond than before middle age, though it may occur in infancy, and a case has been reported in which the disease arose at the age of seventy. It is more frequently met with in women than in men, and pregnancy seems to bear more than a casual relation to its production. In osteomalacia the medulla increases in bulk and becomes more fatty, and the osseous matter is absorbed gradually, first from the cancellous tissue and then from the compact tissue. Some observers believe that this curious condition is due to lactic acid in the blood, an abnormal amount of acid having been produced and absorbed because of disorder of the primary assimilation. Volkmann maintained that some inflammatory condition disturbs the blood-supply of the medulla, and von Recklinghausen asserts that arterial hyperemia is responsible. Hönnicke suggests that the disease is due to hypersecretion of the thyroid gland.

Fehling, influenced by finding that improvement may follow removal of the ovaries, set forth the view that the disease is due to overaction of the ovaries, causing reflex dilatation of the blood-vessels of bone. This explanation fails entirely to account for the disease in men. Some have thought that the disease is of bacterial origin. It is most common in those who dwell in damp or dark habitations. It may arise after a soaking and "taking cold." It is a rare disease in England and America, but is much more common in

Symptoms.—The symptoms of osteomalacia are as follows: many points of pain which are often thought to be due to rheumatism; deformities from twisting and bending of bone; sometimes lactic acid and occasionally an excess

of calcium salts in the urine. There is no fever early in the case, but later there may be a hectic fever. When the disease comes on after childbirth the iliac bones suffer first. Severe pain arises in the pelvis and back and the pain radiates into the thighs, the pain is worse at night, and is greatly aggravated by pressure or movements. Finally, standing and walking become unbearably painful. Fractures occur from very slight force. In the majority of cases the disease is not cured, but grows progressively worse until the patient dies, after many years, from exhaustion. In some cases the process is arrested and the osteoid tissue is calcified.

Treatment.—In treating osteomalacia in women insist that pregnancy must not occur. In all cases put braces and supports upon distorted limbs to prevent further bending and fracture. Advise hygienic surroundings and nourishing food, and insist on the value of fresh air. Among the medicines that can be used may be mentioned cod-liver oil, lime salts, preparations of phosphorus, and bone-marrow. In women the removal of the ovaries sometimes produces great improvement. It has been asserted that the production of anesthesia by means of chloroform may be of benefit.

Acromegaly.—This is a disease which causes progressive and often great enlargement of both the bones and soft parts of the extremities, which enlargement is symmetrical. The cranium becomes triangular in shape, with the base below at the lower jaw. The lower jaw projects in advance of the upper jaw, the nose becomes prominent and thick, the supra-orbital ridges are accentuated, and the costal cartilages and inner ends of the clavicles become protuberant. Later the larynx, ribs, shoulder-blades, and vertebræ become involved, and the back becomes markedly humped (cervicodorsal hump). The hands and feet are effected in advanced cases. As a rule, the thyroid gland is enlarged, and a post-mortem examination may detect an enlarged pituitary gland. Severe and uncontrollable headache is sometimes a distressing feature of the disease. In some cases there is marked somnolence. A fireman who suffered from acromegaly would go to sleep almost the mornent he sat down. The disease slowly but surely causes death. Medical treatment is futile. If there are evidences of tumor of the hypophysis it is Justifiable to undertake its removal by operation. This has been accomplished successfully by Hochenegg, Von Eiselsberg, Brochardt, Cushing, Sir Victor Horsley, and others. In the cases of Hochenegg and Cushing not only were pressure symptoms relieved, but acromegalic conditions were greatly benefited.

Leontiasis Ossium (Virchow's Disease).—This is a symmetrical hypertrophy limited to the facial and cranial bones, and which begins, as a rule, in the superior maxillæ. The hypertrophy progressively increases, causes difficulty of mastication, and is accompanied by headache. It produces distinct deformity of the jaw like a tumor, whereas acromegaly enlarges all of the proportions of a bone (Fig. 233). It may produce blindness, new bone pressing upon the optic nerves. Treatment is not satisfactory, as a rule. Recently Horsley has obtained amelioration by operating and removing masses of bone.

Osteitis Deformans (Paget's Disease).—This disease was first described by Paget in 1877, and about 100 cases have been reported. Packard

and Steele ("Amer. Jour. of Med. Sciences," Nov., 1901) point out that many of the reported cases are not genuine instances of the disease, some being ordinary osseous tumors, others being cases of enlargement after fracture, and still others being instances of mollities ossium. They think that 67 of the reported cases are genuine instances of the disease. In this disease great quantities



Fig. 233.—Leontiasis ossium.

of new bone are formed, but calcification does not occur. The material undergoes absorption, and the medullary substance of the bone becomes extremely vascular and filled with white blood-cells, and also with giant-The fact that the new bone does not calcify leads to various deformities of the long bones, on account of the weight of the body; but fracture is not particularly apt to occur. Numbers of bones may be decidedly thickened. The underlying cause of this curious condition is entirely unknown, but it is assumed to be trophic. It is claimed that it has occasionally arisen after an injury to a long bone, and has been excited into activity by heat and cold. It is extremely rare before the age of forty, and usually begins between forty and fifty. The enlargement of the bones may be first detected in the cranium, but is more often first seen in some other bone -for instance, the clavicle, the tibia, the spine, or the radius. The tibia in most cases suffers first, and other bones become involved later. In fact, in some cases the bones of the head do not enlarge at all; but, taking all the reported cases, the skull is affected more frequently than any of the other bones. In some cases the enlargement of the bones seems to be symmetrical; in others it is not. In the disease known as leontiasis ossium the chief enlargement is manifested in the face; in Paget's disease there is no enlargement of the bones of the face, or else these bones are trivially involved. Packard and Steele point out that the diagnosis is extremely difficult when but a single bone is involved; but that if two or more bones are involved, we should think of Paget's disease as the condition, especially if we are able to exclude syphilis, cancer, and sarcoma. In mollities ossium the head is not involved at all; and there is not nearly so much thickening of the bone. The two authors before quoted show that in acromegaly the cranium is a triangle with its base below at the lower jaw, the orbital arches being chiefly involved; but that in Paget's disease the involvement is chiefly of the calvarium. In this curious malady there may or may not be pain. The patient actually diminishes in height. The chest becomes deformed. There is angular curvature in the dorsocervical region. The lower extremities are usually bent; and the pelvis, as a general thing, is broadened. In the 67 cases collected by Packard and Steele, 3 suffered with cancer and 5 with sarcoma.

Treatment.—Treatment is practically useless. No known remedy diminishes the size of the bones, although iodid of potassium is said occasionally to mitigate the pain, if pain exists.

## FRACTURES.

Definition.—A fracture is a solution, by sudden force, of the continuity of a bone or of a cartilage. Clinically, under this head are placed epiphyseal separations and the tearing apart of ribs and their cartilages.

Varieties of Fractures.—The varieties of fractures are as follows: Simple fracture is a subcutaneous fracture, or one in which there is no

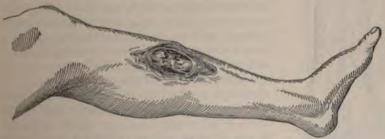


Fig. 234. -Compound comminuted fracture of the tibia.

wound extending from the surface to the seat of bone-injury. This corresponds to a contusion of the soft parts.

Compound jracture (Fig. 234) is an open fracture, or one in which an open wound extends from the surface to the seat of bone-injury or in which a wound opens up a passage from the fracture to the surface. This corresponds to a contused or lacerated wound of the soft parts. The opening may be through the skin; through a mucous membrane, as in some fractures of the base of the skull and pelvis; through the drum of the ear, as in some fractures of the middle fossa of the base of the skull; through the lung, as when a broken rib

penetrates that organ; or through the bowel or bladder, as in some fractures of the pelvis.

A primary compound fracture is one in which the breach in the soft parts

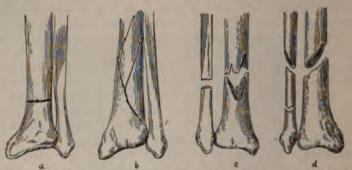


Fig. 235.—Complete fractures: a, Transverse; b, spiral; c, dentated; d, oblique or multiple.

is produced at the time of the accident, either by the direct violence of the injury or by the forcing of a bone or bones through the tissues.

A secondary compound fracture is one in which the breach in the soft parts occurs after the accident, either from sloughing of damaged tissues, from

fragments, through the neglect, or Compliant plication of or injury the tured rib in damages the term is unformand its use speak of "typhoid," any case, the soft p

Fig. 236.—Longitudinal and oblique fracture.

ulceration because of the pressure of ill-adjusted fragments, or from the forcing of a bone or bones through the soft parts because of rough handling, neglect, or the tossing of delirium.

Complicated fracture is a fracture plus the complication of a joint-injury, arterial or venous damage, or injury to the nerves or soft parts. When a fractured rib injures the lung or when a broken vertebra damages the cord a complicated fracture exists. The term is unfortunate, as it conveys no definite meaning, and its use is no more justifiable than it would be to speak of "complicated pneumonia" or "complicated typhoid," for the complication should be named in any case. It must be remembered that damage to the soft parts not sufficiently severe to produce a wound reaching from the surface to the seat of fracture does not make the case a compound fracture, but rather complicates a simple fracture. Remember also that even superficial areas of tissue-destruction must be treated antiseptically, otherwise absorption

of pyogenic bacteria and their deposition at the seat of injury may cause diffuse osteomyelitis.

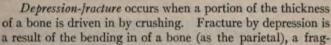
Complete fracture is that which extends through the whole thickness of a bone or entirely across it (Fig. 235).

Incomplete fracture is that which extends only partially through the thickness of a bone or only partially across it.

A linear, hair, capillary, or fissured fracture, or a fissure, is a crack in a bone with very little separation of the edges. This is an incom-

A green-stick, hickory-stick, willow, or bent fracture is a true incomplete break (Fig. 237). The bones most frequently broken are the radius, ulna, clavicle, and ribs. It arises from indirect force, and it is very rare after the age of sixteen. In rickets green-stick fractures are very common. It is called "green-stick" because the bone breaks like a green stick when forced across the knee, first bending and then breaking on its convex surface. The bone, being compressed between two forces, bends, and the fibers on the outer side of the curve are pulled apart, while those on the concavity are not broken, but are compressed. In correcting the deformity such fractures are often made complete. The permanent bending of a bone without a break may possibly occur in youth. In children a portion of a bone of the skull may be bent inward, causing depression. In some cases such a depression is permanent; in others it is temporary, the bone returning to its proper level.

plete fracture, but may be associated with a complete break.



ment breaking off from the side toward which the bone is bending. A depressed fracture is complete, not incomplete, and by this term is

meant an injury in which a fragment of the entire thickness of the bone is driven below the level of the surrounding surface.

Fig. 237.-Greenstick fracture.

Splinter- and Strain-fracture. — The breaking off of a splinter of bone (splinter-fracture) or of an apophysis constitutes a form of incomplete fracture. A strain upon a ligament or a tendon may tear off a shell of bone, and this injury is the "strain-fracture" or "sprain-fracture" of Callender.

Longitudinal fracture is a fracture whose line is for a considerable distance parallel, or nearly so, with the long axis of the bone. Such fractures are common in gunshot-injuries (Fig. 236).

Oblique fracture is a fracture the direction of which is positively oblique to the long axis of the bone. Most fractures from indirect force are oblique (Fig. 235, d).

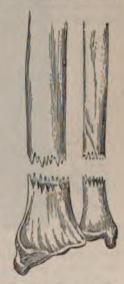


Fig. 238.—Appearances of the ends of fragments.

Transverse fracture is a fracture the direction of which is nearly transverse to the long axis of the bone (no fracture is mathematically transverse) (Fig. 235, a). The cause is often, but not invariably, direct force. The "fracture en rave" (radish-fracture, so called be-

cause the bone breaks as does a radish) is transverse at the surface, but not within.

Toothed or dentate fracture is a form of fracture in which the end of each fragment is irregularly serrated and the fragments are commonly locked together; hence it is difficult to correct the deformity (Fig. 235, c, and Fig. 238). Most simple fractures from direct force are serrated.



Fig. 239.—Impacted fracture of the neck of the femur.



Fig. 240.—Impacted fracture of the neck of the femur.

Wedge-shaped, V-shaped, cuneated, or cuneiform fracture ("fracture oblique spiroïde," "fracture en V" of Gosselin, "fracture en coin") is one the lines of which take the shape of a V, which may be entire or may lack the point. It occurs at the articular extremity of a long bone, and a fissure usually arises from its point and enters the joint. If complete, it is a "comminuted fracture."



Fig. 241.—Comminuted fracture of the lower extremity of radius.

T-shaped fracture is a fracture which presents a transverse or oblique line and also a longitudinal or vertical line. It occurs at the lower end of either the humerus or femur, the transverse line being above, and the vertical line (intercondyloid) between, the condyles. If complete, it is in reality a form of comminuted fracture.

Multiple or composite fracture is a condition

in which a bone is broken into more than two pieces, the lines of fracture not intercommunicating, or a condition in which two or more



Fig. 242.—Comminuted fracture of the upper part of femur.

bones are broken. Multiple fractures of one bone are divided into double, treble, quadruple, etc. Multiple fractures involving more than one bone are seldom seen, and represent less than 2 per cent. of fracture cases. The reason of their

rarity in hospitals is that they result from severe force and many of the victims die before they can be brought to an institution. The mortality in cases which reach the hospital is large, over 27 per cent. (Astley P. C. Ashhurst, in "Annals of Surgery," August, 1907).

Comminuted fracture is a condition in which a bone is broken into more than two pieces, the lines of fracture intercommunicating (Figs. 241 and 242).

The bone may be broken into many small fragments, there may be much splintering, or the osseous matter may actually be ground up.

Impacted fracture is one in which one fragment is driven into the other

and solidly wedged (Figs. 239, 240, and 243).

Fracture with crushing or penetration is a fracture in which one bone is driven into the other, the encasing bone being so splintered that the impacting bone is not firmly held.

Pathological, spontaneous, or secondary jracture is one occurring from a very insignificant force acting on a bone rendered brittle by disease.

Ununited fracture is a fracture in which bony union is absent after the passage of the period normally necessary for its occurrence.

Direct fracture is one occurring at the point at which the force was primarily applied.

Indirect fracture is one occurring at a point distant from the area of

primary application of force.

Stellate or starred fracture (fracture par irradiation) is one in which several fissures radiate from a center. If the fractures be complete, the condition is in reality a form of comminuted fracture.



Fig. 243,-Impacted fracture of neck of femur (Conner).

Helicoidal, spiral, or torsion fracture is a fracture resulting in a long bone from twisting.

Fracture by contrecoup is a fracture of the skull which is on the opposite side of the head to that which was the recipient of the force.

Epiphyseal Separation or Diastasis.—This injury occurs only before the age of twenty-five. In order of frequency, the bones chiefly subject to epiphyseal separation are: the upper end of the humerus, the lower end of the radius, the lower end of the femur, and the lower end of the tibia (John

Poland, in the "Practitioner," Sept., 1901). This injury induces deformity, which is often difficult to reduce, and by damaging the cartilage may retard or inhibit a further lengthening of the limb by growth. Occasionally, after damage to an epiphysis suppuration will occur, sometimes thickening takes place. Non-union is very rare. After a sprain of an epiphysis tuberculous disease sometimes develops, but very rarely after a separation.

Intra-uterine fractures are usually due to injuries of the mother's abdomen sustained toward the end of pregnancy. Some hold that they can arise as a consequence of the force of violent uterine contractions. Many so-called "intra-uterine" fractures are wrongly named, as they result from injury during delivery. In sporadic cretinism the bones are fragile and ill-ossified,

and many fractures may occur in utero.

Designation According to Seat of Fracture.—A fracture may be designated according to its anatomical seat; for instance, fracture of the upper third of the shaft of the femur, fracture of the olecranon process of the ulna, fracture of the middle third of the clavicle, and fracture of the body of the lower jaw. Intra-articular fracture is one extending into a joint; intracapsular fracture is one within the capsule of either the shoulder- or hip-joint; and extracapsular fracture is one just without the capsule of either the shoulder-or hip-joint.

Causes of Fracture.—The causes of fracture are (1) exciting, imme-

diate or direct, and (2) predisposing or indirect.

Exciting causes are (a) external violence and (b) muscular action.

External violence is the most usual exciting cause. Two forms are noted:

(1) direct violence and (2) indirect force.

Fractures from direct violence occur at the point struck, as when the nasal bones are broken with the fist. In such fractures the soft parts are injured; they may be destroyed at once in part, they may be damaged so severely that a portion sloughs, or they may be damaged so slightly that they do not lose vitality; hence fractures by direct violence may be compound from the start, may become so, or may remain simple. In fractures by direct force discoloration, due to effused blood, usually appears at the point struck soon after the accident. In compound fractures by direct violence the soft-part injury is so great that primary tissue-union cannot occur.

Fractures from indirect force do not occur at the point of application of the force, but at a distance from it, the force being transmitted through a bone or a chain of bones, as when the clavicle is broken by a fall upon the extended hand. Such fractures tend to occur in regions of special predilection. If they are not compound, there is no injury of the surface over the fracture. If they become compound by projection of fragments, primary union may still occur. Discoloration over the seat of fracture is usually not present soon after the accident, but may occur later. Discoloration rapidly appears in soft parts at the point where the force was first applied.

Muscular action is rather an unusual cause. Fractures thus produced result from sudden or violent muscular contraction. Bones so broken are usually diseased. Violent coughing may fracture the ribs; attempting to kick may fracture the femur; saving one's self from falling backward may fracture the patella; throwing a stone may fracture the humerus; and sudden extension of the forearm may fracture the olecranon process of the ulna.

Predisposing Causes.—There are two classes of predisposing causes, namely: (1) physiological, natural or normal, and (2) pathological or abnormal.

Natural Predisposing Causes.—Under this head is considered the liability to fracture possessed by individual bones because of their shape, structure, function, or position. Those predispositions occasioned by special ages are also considered. In youth epiphyseal separation is commoner than fracture and a fracture is apt to be incomplete. Fractures are commonest between the ages of twenty-five and sixty. From two to four years of age a child is more liable to fracture than later, because he is then learning to walk (Malgaigne). The bones of the old are easily broken, but the normal lack of activity of the aged saves them from more frequent injury. Thus the predispositions of age are in part due to habits and in part to bony structure. The bones of the young, being elastic, bend considerably before they break; the bones of the old, being brittle and inelastic, break easily, but do not bend. In old age the bones become lighter and more porous, though they do not diminish in size. Absorption takes place from the interior of a bone, particularly at its articular head, the medullary canal increases in size, the cancellous spaces become notably larger, and portions of the remaining bone of the interior show a fatty change. There is no increase in the amount of mineral salts present, as was long taught. These alterations occur earlier in women than in men.\* The change of age is a diminution in the amount of bone present, and sometimes a fatty change in a portion of what remains. If the atrophy of bone is other than that normal to senility, it constitutes a pathological predisposing cause of fracture. Normal predisposing causes include the person's weight (which determines the force of a fall), muscular development, habits, sex, occupation, and the season of the

Pathological Predisposing Causes.—Hereditary jragility, a form of jragilitas ossium, is a condition commonest among women, often existing in generation after generation, and in this condition fractures occur from a very slight force. There exists in these cases bony rarefaction—in fact, a premature senility. Fragilitas ossium (osteopsa-thyrosis) may be congenital or may come on later in life. It may result from senility, wasting diseases, scurvy, scarlatina, bone-cyst, malignant disease of the bone, certain nervous disorders, nickets, osteomalacia, and atrophy due to disuse.

Nervous Diseases.—Bony nutrition is dependent on the spinal cord, and the trophic influence is probably exerted through the posterior nerve-roots (Gowers). In diseases of the anterior cornua bony growth is much interfered with; in diseases of the posterior columns, as in locomotor ataxia, a true bony atrophy bespeaks trophic disorder. Syringomyelia causes brittleness of the osseous structures, and in paralysis agitans bones are thought to break easily. Trophic changes may occur in the bones of the insane, most commonly when insanity is linked to organic disease. About one-quarter of paretic dements show undue brittleness or unnatural softness of bones.† The bones of maniacs are frequently fragile. Fractures among the insane are not necessarily an indication of abuse.

Rickets.—Rickets predisposes to fracture because of altered bone-structure and the great liability to falls.

<sup>\*</sup> Humphrey on "Old Age."

Osteomalacia predisposes to fracture of the long bones, sternum and ribs. Atrophy of Bone.—This condition, as has been stated (page 500), is normal in senility. It may arise from want of use, as is observed in the bedfast in the wasted femur of hip-joint disease, and in the bones of a stump. It may arise from pressure, as when an aneurysm compresses the ribs, sternum, or vertebræ. Among other of the pathological predisposing causes are to be mentioned cancer, sarcoma, hydatid and solitary cysts of bone, caries, necrosis, gout, scrofula, syphilis, mollities ossium, and scurvy.

Symptoms of Fracture.—History of an Injury.—In spontaneous fracture there may be no record of violence; for instance, a bone may break while an individual is turning in bed. In investigating the history, not only seek for a record or for evidences of violence, but try to determine exactly

how the accident happened.

A sound of cracking is occasionally audible to a bystander at the time of the injury. The patient may have heard it, but very rarely does. A

rupture of a tendon or a ligament produces a similar sound.

Pain is usually, but not invariably, present (absent often in rickets). Malgaigne says that in some fractures the pain is slight or absent, in others it is torturing, and in most it is severe for a time after the injury, but gradually abates unless reinduced by movement. Pain developed at the time of the accident is far less important as a symptom than that which can subsequently be produced by movement. In indirect fracture there is an area of pain at the point of application of the force, and another at the seat of fracture. Pain at the seat of fracture can be greatly aggravated by pressure or movement and is rather narrowly localized.

Deformity or alteration in length or outline is due in part to swelling and in part to a change in the mutual relation of the fragments (displacement). The deformity due to swelling is no aid to diagnosis, as the same condition occurs in contusion, and often hides some positive symptomatic distortion. The swelling is due first to blood and next to inflammatory products and pressure-edema, and is very great in joint-fractures. Swelling due to bleeding is early and rapid. Swelling due to inflammatory exudation is later and gradual. Swelling due to pressure-edema may be rapid. The greater part of the swelling is due to hemorrhage and exudation from the damaged soft parts, a portion of it is due to hemorrhage and exudation from the bone. The swelling is usually in direct ratio to the mobility, the greater the mobility the greater the swelling. "The swelling in fractures of the skull is inconsiderable, notwithstanding that the total area of bone surface involved is commonly more than in fractures of the leg or arm, and the vascularity greater. The reason for this is the natural immobility of fractures of the skull" (James P. Warbasse, in "Jour. Am. Med. Assoc.," March 13, 1909). The deformity of displacement may be produced by the violence of the injury (as is the depression in a skull-fracture), by the weight of an extremity (as is the falling of the shoulder in a fracture of the clavicle), or by muscular action (as is the pulling upward of the fragment of a fractured olecranon process).

The varieties of displacement are (1) transverse or lateral, where one fragment goes to the side, front, or back, but does not overlap the other; (2) angular, the bony axis at the point of fracture being altered and the fragments forming with each other an angle; (3) rotary, one fragment rotating

in the bony circumference, the other remaining stationary. As a rule, it is the lower fragment which turns on its long axis, the limb below the level of the break rotating with it; (4) overlapping or overriding, when the upper level of one fragment is above the lower level of the other fragment. It is usually the lower fragment which is drawn by the muscles above the upper, but in a fracture of the lower extremity the body-weight and sliding down in bed may push the upper below the lower fragment. In overriding the ends are near together and the bones are usually in contact at their periphery. It is obvious that overlapping is associated with transverse displacement, as one fragment must go front, back, or to the side; (5) penetration or impaction when one fragment is driven into the other, thus producing shortening; (6) separation of the two fragments occurs in fracture of the patella, olecranon, os calcis, certain articulations, and in some breaks of the humerus when the arm is not supported.

It is important to remember that a dislocation as well as a fracture may produce displacement, but these two conditions may be differentiated by the observation that the displacement of fracture tends to reappear even after complete reduction, while the displacement of dislocation does not reappear after correction. A displacement is difficult of detection in a flat bone and when one of two parallel bones is broken.

Loss of function may be shown by inability to move the limb because of the break, but it is not always markedly present, though some degree invariably exists. It is slight in "green-stick" and impacted fractures (unless the loss of power arises from pain or nerve-injury). A person can walk when the fibula alone is broken, and likewise in some cases of intracapsular fracture of the femur, and can often put the hand on the head in fractured davide (Malgaigne). The pain of any injury or the loss of power from nerve-traumatism may cause loss of movement in the limb. This symptom is of slight diagnostic value in most fractures.

Extravasation of Blood.—A contusion of the surface accompanied by skinabrasion indicates merely the point of application of direct external violence. If contusion is extensive over a superficial bone, as the tibia or parietal, after a few hours it often simulates fracture by presenting a soft, compressible center surrounded by a ring of hard, condensed tissues and coagulated blood. Direct external violence may merely occasion ecchymosis, and in fracture from indirect force ecchymosis may occur throughout a considerable area. In regard to this symptom, note that even great external violence may occasion no evident contusion or ecchymosis, and in any fracture this symptom may be present or absent. In old people, anemic subjects, alcoholics and opiumcaters, extravasation of blood is frequently marked and persistent. By suggillation is meant an extravasation of blood which slowly invades wide areas of tissue and which appears at the surface only after some time, and then usually as a vellowish discoloration, red hemoglobin having been changed to yellow hematoidin. Linear ecchymosis has been esteemed by some as a sign of fissure, and it is often noted after fracture of the fibula. Linear ecchymosis over the line of the posterior auricular artery was shown by Battle to be a valuable sign of fracture of the posterior fossa of the base of the cranium.

Preternatural mobility is a most important symptom, which is pathogno-

monic when surely found. The unbroken bone is nowhere mobile in continuity. By preternatural mobility is meant that a bone is mobile in continuity or that there is abnormality in the direction or extent of joint-mobility. In some fractures this symptom does not exist (impacted, green-stick, and locked serrated fractures): in others it cannot be found (fractures of tarsus, carpus, vertebral bodies); in others it is difficult to obtain, but at times can be developed (fractures near or into many joints). To develop this symptom, try, when the case admits, to grasp the fragments and to move them in opposite directions. In a fracture of the shaft of the femur or humerus fix the upper fragment and carry the knee or elbow in various directions to develop bending at the point of fracture. In fracture of the clavicle push the shoulder downward and inward. In fractures of either bone of the forearm grasp the parallel bone with four fingers of each hand and make pressure on the suspected bone alternately with either thumb, and the same procedure can be used in fractures of the leg. In fracture of the neck of the femur the altered rotation-arc of the great trochanter demonstrates preternatural mobility (Desault). In fracture of the lower end of the radius bend the hand back, and in a break of the lower end of the fibula evert the foot (Maisonneuve). In seeking preternatural mobility, remember that the elastic ribs when forced in give a sense of bending, and that the fibula at its middle is "normally flexible" (Dupuytren). Some rachitic bones may be bent.

Crepitus or crepitation is both a sensation and a sound, which indicates the grating together of the two rough surfaces of a broken bone. This symptom is of great value, but it is not always present. It is absent in locked serrated fractures, in impacted fractures, in cases where the broken ends cannot be approximated (as in overlapping), is rare when a fractured surface is against the side, and not the broken face, of the other fragment, and is unusual in incomplete fractures. Crepitus is often absent in epiphyseal separation, in softened bones, and in fractures in or near joints, and it may be prevented from occurring by blood-clot, fascia, synovial membrane, periosteum, or muscle between the broken surfaces. The grating found in tenosynovitis must not be mistaken for the crepitus of fracture: the former is diffuse, large, soft, and moist; the latter is limited, small, harsh, and dry. The clicking of an inflamed or eroded joint and the crackling of emphysema must also be separated from bony crepitus. Crepitus of fracture may be present at one moment, but absent the next. It is often not detected during the time swelling is marked, and cannot be discovered after organization of the callus begins. In but few fractures is it needful to try to hear crepitus with the unaided ear or with a stethoscope upon the part, but in doubtful cases of fractures of ribs and joints this evidence should be sought for.

The above-named symptoms are known as "direct." There are other symptoms known as "circumstantial," such as the flow of blood and cerebrospinal fluid from the ear after some fractures of the middle fossa of the skull; emphysema of the face and epistaxis after fracture of the nasal bones; hemoptysis and emphysema after crushes of the chest; discoloration following the line of the posterior auricular artery after fracture of the posterior fossa of the skull; and subconjunctival ecchymosis after fracture of the anterior

fossa of the skull.

Diagnosis.—Examine as soon as practicable after the injury—before the onset of swelling, if possible. Expose the part completely, taking off the clothing, if necessary, by clipping it along the seams. Attentively scrutinize the part and compare it with the corresponding part on the opposite side. If any deformity be present, it must be ascertained that it did not exist before the accident. If the nature of the injury be uncertain, if the patient be very nervous, or if the part be acutely painful, it is better to give ether to diagnosticate, set, and dress. In injuries of the elbow-joint anesthetize before examination, unless an x-ray apparatus is accessible to settle the diagnosis, and even then it is usually well to anesthetize in order to facilitate reduction and dressing. In every case of suspected fracture get an x-ray picture if possible. A correct diagnosis is of the first importance and on a correct diagnosis proper treatment primarily depends.

A fracture is distinguished from a dislocation by its preternatural mobility, its easily reduced but recurring displacement, and its crepitus, as contrasted with the preternatural rigidity, the deformity, difficult to reduce but remaining reduced, and the absence of crepitus of a dislocation. Further, in dislocation the bone, when rotated, moves as one piece, whereas in fracture it does not so move; in dislocation the bony processes are felt occupying their proper relations to the rest of the same bone, while in fracture some of them present altered relations. In dislocation the head of the bone is found out of its socket, but in fracture it is felt in place. It is important to remember, moreover, that a fracture and a dislocation may occur together, and that the rubbing of a dislocated bone against an articular edge, when the joint has

been roughened by inflammation, simulates crepitus.

Great contusion, by inducing extreme tumefaction, may mask characteristic deformity and obscure crepitus. When only a contusion exists, pain is apt to be widespread; but if a fracture has occurred, the pain is accentuated at some narrow spot. In many cases, before he can give a certain opinion, the surgeon must wait some days until the swelling has largely subsided. In such a case it is best to assume in our treatment that a fracture exists until the contrary is known. Combat swelling by rest, the use of

evaporating lotions, and moderate compression.

In impaction the diagnosis is difficult. The moderate deformity is concealed by swelling; crepitus and preternatural mobility do not exist unless the fragments are pulled apart, and there is not necessarily much loss of function. A conclusion is reached largely by considering the nature, direction, and extent of the violence, the seat of the pain, and by a careful study of the most minute deformity. It is difficult to recognize fissures. They rarely present any evidence of their existence except a localized pain, and

Possibly a linear ecchymosis appearing after a few days.

In green-stick fractures the age, the deformity, and possibly crepitus during reduction help in the diagnosis, although in many cases no crepitus is obtained. Epiphyseal separations are diagnosticated by the age, the preternatural mobility, the pain, the swelling, the ecchymosis, the deformity, the situation of the injury, and the absence of crepitus or the presence only of a soft crepitus. It is important, however, to remember that an epiphyseal separation is sometimes incomplete, and even when it is complete there may be no displacement. In cases without displacement the x-rays will

not enable us to make a diagnosis. In many cases of complete separation soft crepitus is obtainable; but in not a few cases it is not to be found. In incomplete separation crepitus is absent. If absent in complete separation, probably some tissue is between the lines. Fractures are often difficult to recognize when occurring in a group of bones (which are firmly joined by dense ligaments) like those of the carpus and tarsus, or in one of two parallel bones. There is not always a certainty that a fracture exists, and when, after a careful examination, there is still an uncertainty, do not prolong the efforts or use great force, but treat the case as a fracture until a cure ensues or the diagnosis becomes apparent.

In a child the diagnosis of fracture is sometimes difficult. Pain may be trivial. Children are liable to a form of fracture in which the periosteum is but slightly torn or is not torn at all, the disability and pain are often slight,

and the fracture may be easily overlooked (Cotton and Vose).

We have recently had added to our resources a method of incalculable value in diagnosticating fracture; that is, the use of the force known as the x-ray or the Röntgen ray. We can look through a part with a fluoroscope and see the bones as shadows, or we can take a negative of the shadows and print skiagraphs from it. This method is applicable even when the parts are swollen, and even when a limb is clothed or wrapped in dressings. It is possible to obtain a picture of a fractured skull after long exposure; fractured ribs and vertebræ can be detected; and the process is of the greatest use in detecting fractures of the limbs. It is not infallible. An epiphyseal separation may not be detected, and a slight angling of the plate may give a deceptive appearance of distortion. An x-ray picture, to be useful, must be taken by an expert and should be interpreted by a surgeon. It is imperative to employ this method in doubtful cases, if an x-ray apparatus is accessible. It is advisable to use it in all recognized cases and in all suspected cases.

Complications and Consequences.—Some of the consequences and complications of fractures are-sloughing of the soft parts, thus making the fracture compound; extravasation of blood, causing swelling or even gangrene; rupture of the main artery or vein of the limb; dislocation; edema from pressure of extravasated blood, from inflammatory exudation, from tight bandaging, from thrombosis, or, later, from the pressure of callus; stiffness of joints from synovitis with adhesion, from displaced fragments, or from intra-articular callus; stiffness of tendons from adhesive thecitis or from the pressure of callus; paralysis from traumatic neuritis, the pressure of callus upon nerve-trunks, or from division of a nerve; muscular spasm; painful callus; exuberant callus; embolism; fat-embolism; pulmonary congestion; gangrene; shock; septicemia; pyemia; tetanus; delirium tremens; urinary retention; extensive laceration of the soft parts; rupture of large nerves: and involvement of joints. A fracture may fail to unite, fibrous union or cartilaginous union only being obtained. An epiphyseal separation may arrest the future growth of the limb.

Repair of Fractures.—Simple Fracture.—In a simple fracture the bone is broken, the medullary contents are lacerated, the periosteum is torn, and the overlying soft parts are damaged to a considerable degree. The periosteum is stripped more or less from each fragment, but it is rarely completely torn through, an untorn portion known as the periosteal bridge re-

maining. The amount of blood effused is usually considerable, and it forms a decided prominence at the seat of fracture; it gradually gathers because of oozing, and soon clots. This clot lies in the medullary canal, between the fragments, under the periosteum at the ends of the fragments, and in the tissues outside of the periosteum. Very rapidly after the accident the damaged parts inflame (bone, endosteum, periosteum, and the torn periosseous structures). The inflammatory exudate enters into the blood-clot and the leukocytes eat up and destroy the clot. The clot is simply dead material and in no way contributes to repair. The cells of the damaged tissue proliferate and the young proliferating cells (fibroblasts) enter into the spaces in the blood and clot eaten out by the leukocytes. Finally the entire clot is replaced by fibroblasts and much of this cellular mass quickly becomes vascularized (granulation tissue).

The osteoblasts, which exist in the deeper layers of the periosteum and in the tissue of the medulla itself, begin to proliferate actively soon after the fracture has taken place. The fibroblasts have been formed by the proliferation of the ordinary connective-tissue cells, and the proliferating osteoblasts soon enter into and become widely distributed through this mass of fibroblasts. Some maintain that the fibroblasts themselves are directly



Fig. 244.—Ununited compound fracture.

transformed into bone; other observers deny this, and think that all boneformation comes from the osteoblasts. Osteoblasts may form bone directly, or may form cartilage first and then bone. When a fracture takes place, a bridge of periosteum is usually left untorn; and this bridge holds the fragments in contact at some point, just as a strap nailed to a trunk and also to its lid might hold these two objects in contact at some point. The new tissue about the periosteal bridge always becomes cartilaginous for a time; but the rest of the callus rarely shows the development of cartilage, and passes directly into bone. If, however, osteoblasts fail to proliferate with sufficient activity, the mass of granulation tissue becomes fibrous tissue; bone is not formed at all, or is very scantily formed; and fibrous union occurs. If the osteoblasts lack activity, but are more active than in the case just cited, they form cartilage extensively-but cartilage only; consequently, cartilaginous union occurs. During the process of the repair of a fracture the ends of the bony fragments are always softened, and some of the bone is absorbed by the osteoclasts. The osteoclasts are really large osteoblasts that have lost the power of producing bone and that furnish a secretion to absorb bone (the elder Senn). After bony union has been accomplished the osteoclasts absorb the superfluous callus. The mass of new tissue around and between the bone-ends is called callus. It will be observed that the name is applied successively to fibroblastic tissue, granulation tissue, fibrous tissue, and bone. Warren tells us that callus has no well-defined outline, and "involves not only the bone and periosteum but also the connective tissue and some of the surrounding muscular tissue." Within a few days after the injury the inflammatory mass is much firmer than follows inflam-

> mation involving other structures, and the bone-ends are deeply imbedded in a dense mass.

> During the second week the callus is greatly strengthened by the formation of dense fibrous tissue in and below the periosteum, of less dense fibrous tissue outside the periosteum, and of cartilage from the periosteal bridge. The newly formed tissue contracts decidedly. During the third week ossification begins at the points farthest from the fracture, and in the course of a short time (from three to six weeks) is complete. The mass of ossified callus, or new bone, is spindleshaped and spongy.

> The greater the amount of motion, short

The term intermediate, definitive, or permanent callus is used to describe the material which forms between the ends of the broken bone. The name provisional or temporary callus is given to the material within the canal (central callus) and external to the bone (ensheathing callus). The amount of provisional callus depends directly on the extent of separation and the amount of motion between the fragments. It is Nature's splint, and when the break is not well immobilized a large amount is formed.

of a degree sufficient to cause non-union, the larger the amount of provisional

The ensheathing callus is after a time largely absorbed, and the central callus in the course of a long time may also be absorbed, with the restoration of the medullary canal, although this latter result is rare. An excessive amount of provisional callus may ossify nearby tendons, may unite two parallel bones (radius to ulna, tibia to fibula, a rib to its neighbors), may block a joint just as a stone in the crack of a door will block a door, or may absolutely abolish a joint. Fragments, even if entirely detached, often unite, but they may be surrounded by provisional callus; sometimes they do not cause trouble, but sometimes suppuration takes place. It takes about one



Fig. 245.—Ununited fracture of humerus; unsuccessful wiring.

year for Nature to remove the temporary callus. The definitive or permanent callus after a time ceases to be porous and becomes very dense bone.

Compound fractures without much destruction or bruising of soft parts, if treated antiseptically, become at once simple fractures and unite as such. If the wound is not drained and asepticized and septic inflammation occurs, pus forms, and union by granulation is the best that can be obtained. Compound fractures by direct violence will not heal by first intention because

of the loss of vitality of a large area of the soft parts.

Delayed union is usually due to imperfect approximation of the fragments. This imperfect approximation may result from failure to reduce the fracture (muscle, ligament, or synovial membrane being caught between the ends of the bone); the use of unsuitable splints; too tight application of bandages; and general causes of ill health, for instance anemia, scurvy, Bright's disease, rickets, syphilis, and pregnancy. In delayed union there is pain on passive motion; in non-union there is not. In delayed union there is loss of voluntary motion; in non-union there is power of voluntary motion (A. H. Tubby, in "Brit. Med. Jour.," Dec. 7, 1901). Delayed union is not non-union, but may eventuate in non-union.

Vicious or faulty union is union with great deformity. This occurs when no treatment has been employed, or when immobilization has been imperfect, or when deformity has not been reduced. It may arise because retentive dressings have been removed by the patient at too early a period, the callus yielding. In many cases it is slight and produces little or no pain or impairment of usefulness. In other cases it is pronounced and produces functional impairment or disastrous pressure on nerves or vessels. Vicious union near a joint always impairs function. If there is pronounced vicious union the bone should be rebroken and set as a fresh fracture. In some recent cases the bone is broken by manual force, and for several weeks after a fracture this can be easily accomplished. In older cases osteotomy should be performed.

Non-union of Fractures. - An ununited fracture is a fracture in which union is not effected at all or in which it is not brought about by bone. Nonunion is especially common in fractures of the upper third of the femur and of the middle third of the humerus. The causes are local and constitutional. The local causes are: (1) Want of approximation of fragments; a frequent cause of want of approximation is interposition of soft tissues-viz., muscle, fascia, or periosteum; this is the great cause of non-union, the cause responsible for an enormous majority of the cases; if soft tissues are interposed between bone fragments non-union is almost inevitable; (2) want of rest; (3) want of blood-supply (as seen in the heads of the humerus and femur, or when a nutrient artery is torn, or when a thrombus forms in a vein near the fracture); (4) defective innervation; (5) bone-disease; (6) the use of unsuitable splints; (7) tight bandaging. The constitutional causes are debility, scurvy, Bright's disease, syphilis, etc. Sometimes union fails to occur for no appreciable reason. In an ununited fracture the broken ends of the bone round off and the medullary canal of each fragment becomes closed by bone. The fragments may not be held together by any material, or they may be held by very thin and much-stretched fibrous tissue (membranous union), or by strong, thick, fibrous tissue (ligamentous or fibrous union). When the ends of the bones come together, are held by a fibrous capsule, and move on each other, there exists a false joint or pseudo-arthrosis. Such a joint may after a time secrete

serous fluid for lubrication. In very rare cases a fracture once apparently soundly united may at a later period be obviously ununited, callus having been absorbed or broken.

Treatment of Fracture.—If a man is found in the street with a fracture, further injury must be prevented by applying, after cutting off the clothing over the fracture, some temporary support. If an ambulance or patrol-wagon cannot be obtained, move the patient by hand. If the lower extremity be involved, an improvised stretcher (a board or a shutter) is placed on the ground beside the patient, who is laid on the stretcher, the surgeon lifting the injured limb, and the patient is then carried to the hospital



Fig. 246.—Vicious union of fractured bones of the leg. View from inner side of limb (Horwitz).



Fig. 247.—Ununited fracture of the femur-

and carefully transferred to a fracture-bed, of, if taken home, to a small ordinary bed, several boards being placed transversely beneath a rather hard but even mattress. The temporary appliances are now removed and a diagnosis is made by the methods before given. After determining the nature of the injury the fragments must be adjusted. This should, if possible, be done at once, because a fracture remaining unreduced may become compound, the fragments may injure important structures, and they are sure to cause intense pain. Reduction is easily effected during shock, as the muscles are in a state of relaxation. Early reduction and fixation largely prevent swelling. If there is very great swelling, reduction may be impossible, and the part must then be supported, moderate cold, sorbefacients, and gentle pressure being used, ice and tight bandaging, which predispose to gangrene, not being employed. In most cases we can reduce displacement in spite of swelling and cure swelling by the reduction. Set the fracture at the first possible moment. Velpeau's axiom was to reduce fractures at once, regardless of pain, spasm, or inflammation, as reduction is their cure. The longer we wait to reduce a fracture, the greater the amount of force necessary to accomplish it because of progressive infiltration of the soft parts with inflammatory exudate and blood, a process which lessens and finally destroys tissue elasticity.

If the patient is very nervous, if the pain is severe, or if rigid muscles antagonize the efforts of the surgeon, reduce the fracture under anesthesia. In some fractures (as those of the clavicle) adjustment is effected by altering the position, and in others (as those of the femur) by extension and counter-extension; in some by tenotomy, and in some by kneading, bending, and coaptation. When extension is employed, always endeavor to get a point of counterextension. The extension is to be made on the broken bone (if possible, in the axis of the bone), is to be steady, and neither jerky nor violent. In some cases complete reduction is impossible. This may be due to spasm, to swelling, to the catching of soft parts between the fragments, to the existence of a loose fragment, to locking, or to impaction. An impaction by rotation can generally be released, but it is sometimes undesirable to unlock it. If the fragments cannot be adjusted without violence, retain them in the best attainable position, combat the antagonistic cause, and set them properly as soon as possible or else operate.

After adjusting the fragments maintain them in position by some apparatus. All sorts of material are used for splints, among them may be mentioned wood, felt, pasteboard, plaster of Paris, silicate of sodium, tin (Levis), and aluminium (Elsberg). Avoid pressure over joints or bony prominences and particularly guard against tight or improper bandaging. In fracture of a bone of a limb the circulation in the fingers or toes must be observed as an index of circulation in the limb; hence leave those digits exposed. A retentive apparatus should prevent the redevelopment of deformity, and not be itself productive of pain or harm. For the first few days of treatment of a simple fracture the dressing is removed every day, to make sure that deformity has not recurred, and if it does recur the fragments must at once be reset. The splints should be padded thoroughly, especially when over joints or bony prominences, and they should, if possible, fix the joints immediately above and below the break. A primary toller should not be used unless plaster is to be employed. By a primary roller is meant a bandage applied to the extremity before splints are placed upon it.

Some surgeons at once apply an immovable dressing. This proceeding is sale in simple fractures without much displacement or soft-part injury. This dressing is valuable in military practice, for the old and feeble whom we fear to put to bed, for the young who are very restless, and for the insane or the delirious. If, however, there is great deformity, much soft-part injury, or marked swelling, immovable dressings may induce sloughing, edema, gangrene, or faulty union. In the above-named cases use splints for the first few days; then, if it is desirable, the immovable dressing can be applied. Plaster-of-paris bandages are unsafe in very young children, and gangrene may occasionally result from their application. It is dangerous to keep old or feeble persons long in bed, as they are prone to develop bed-sores and hypostatic pulmonary congestion. The period for the artificial retention of the fracture varies with the seat of the fracture and the age and condition of the patient. Passive

motion is to be made in most fractures in from two to three weeks, though it is sometimes made earlier to prevent ankylosis and sometimes later because of risk of non-union. Landerer strongly advocates massage, believing that it hastens union and prevents wasting. He applies it as soon as there is no danger of the callus bending (in from eight to fourteen days). Massage should not be used when great edema points to the possibility of venous thrombosis. The movements might break up a clot and cause fatal embolism.\* Very early massage may cause fat-embolism. In fracture of the patella, Barker and many others believe in wiring, and some surgeons advocate the same procedure



Fig. 248.—Ambulatory dressing of plaster-of-Paris for fracture of the bones of the leg (Pilcher).

Fig. 249.—Ambulatory dressing apparatus for fracture of thigh (Harting).

in fracture of the clavicle, fracture of the tibia, and fracture of the upper third of the femur. If fragments cannot be approximated or retained by ordinary methods, an incision should be made, approximation effected, and the fragments retained by wire, a clamp, or a bone ferrule.

The plan known as the ambulatory treatment of fractures of the lower extremities has had warm advocates. The ambulatory splint is an apparatus which enables a man to walk about a few days after receiving a fracture of the leg or thigh. It was devised by Hessing, a carpenter dwelling in a village near Augsburg. Its aim is not only to get the patient about on crutches, but also to cause him to use the limb. It is held that this plan of treatment greatly lessens the patient's sufferings and actually favors union by the stimulation of walking. Bardeleben, in his report to the German Surgical Congress, gave the

<sup>\*</sup>Cerne's case, in "Normandie méd."; Bull. méd., 1895, No. 44.

records of 111 fractures of the lower extremity thus treated (77 simple and 12 compound fractures of the leg; 17 simple and 5 compound fractures of the thigh). The patients were gotten about a few days after the accident, were able to attend to business, had excellent appetites, digested their food perfectly, slept well, and were saved from muscular atrophy. Pilcher has warmly advocated the method. It can be used in fractures as high up as the middle of the femur. The apparatus which we should employ in the ambulatory treatment reaches below the sole of the foot, and is supported firmly above the seat of fracture, the weight of the body being transferred from above the fracture to the firm pad below the sole of the foot on which the patient walks (Figs. 248 and 249). This appliance in a fractured thigh is put on about one week after the infliction of the injury. While the patient sits on the ischial tuberosities extension is made upon the leg. The seat of fracture is encircled with a thin plaster cast. The sole of the other foot is raised by a cork sole. Albers, when he treats a fractured thigh, uses plaster-of-Paris strengthened by bits of wood, running from below the sole of the foot to the iliac crest. Krause says in fracture of the ankle carry the dressing to the head of the tibia; in fracture of the leg carry it to the middle of the thigh; in fracture of the lower end of the femur carry it to the pelvis.\* Bradford warmly advocates the use of Thomas's splint often combined with plaster of Paris. During the last few years surgeons have come to recognize that ambulatory treatment must not be used for all fractures of the lower extremity and is only suited to selected cases.

Prevention and Treatment of Complications.—In every case of fracture of an extremity feel for the pulse between the periphery and the seat of injury in order to be sure the artery is not ruptured. If the soft parts are badly contused, try to prevent sloughing by employing rest and relaxation, and by applying heat. If superficial sloughing occur, treat antiseptically, remembering that even a superficial excoriation can admit bacteria which, carried by the blood or lymph, may infect the bones. If a slough leads down to the fracture, treat the case as a compound fracture. If there be great blood-extravasation the danger is gangrene, and after fracture of the lower extremity the foot of the bed may be elevated, or, better, after fracture of the upper or lower limb the extremity, to which splints and bandages are to be loosely applied, is to be raised and surrounded with hot bottles. If a bleb forms, it is to be opened with a clean needle and dressed antiseptically. If gangrene occurs, treat by the usual rules. Frequently after fracture of a bone blebs containing reddish scrum form on the skin. The appearance of blebs when the circulation is good does not mean gangrene, and is not of any particular consequence. If blebs are due to gangrene, there are distinct symptoms of circulatory impairment.

Edema may be due to tight bandaging. If it is due to phlebitis, there is danger of pulmonary or cerebral embolism. In phlebitis elevate the limb, remove all constriction, and employ locally ichthyol ointment; do not use massage, and give stimulants by the mouth. In edema due to weak circulation or venous relaxation use daily frictions and firm bandaging. If the fracture involves a joint, carefully adjust the fragments, make passive motion early, and inform the patient that he will probably have a stiff joint.

A dislocation occurring with a fracture is reduced at once if possible. To do this, splint the limb and give ether, and try to reduce while the limb is managed with the splint as a handle. Allis is often able to reduce a dislocation

<sup>\*</sup> Centralbl. f. Chir., vol. xxii, 1895.

accompanied by a fracture. He uses the untorn portion of periosteum as a hinge, pulls upon the lower fragment, and thus draws down the upper frag-



Fig. 250.-Fracture-hook (McBurney and Dowd).

ment and pushes it in place by manipulation. If this fails, it is best to incise and pull the separated end in place by the hook of Mc-Burney and Dowd (Figs. 250-252); but some surgeons say, get the bones in the best possible position, set them, await union, and then treat the unreduced dislocation. A rupture of

the main artery of the limb presents the symptoms of absent pulse below the rupture, a tumor which may pulsate, and possibly a whirring sound or an aneurysmal thrill and bruit. This condition demands that the surgeon should apply an Esmarch bandage, cut down upon the tumor, turn out the clot, and ligate each end of the vessel. Rupture of the main vein of a limb causes intense

edema and calls for sutures, lateral ligatures, or complete ligation. If these measures fail after injury of vein or artery, or if gangrene appears, amputate at once above the seat of the fracture.

Inflammation is to be treated by compression, rest, moderate cold, and later by a 50 per cent. ichthyol ointment. Muscular spasm re-

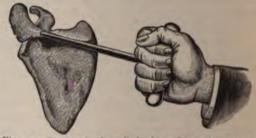


Fig. 251—Fracture-hook applied at base of acromion process (McBurney and Dowd).

quires morphin internally, firm bandaging, or even tenotomy. Fat-embolism is treated by stimulants and inhalation of oxygen, and possibly artificial respiration. Shock, delirium tremens, urinary retention, etc., are treated according to the ordinary rules of surgery.

Treatment of Compound Fractures.—It must first be decided, in a case of compound fracture of a limb, if amputation is necessary, and the x-rays are of great value in determining the condition of the bones in a crushed part.



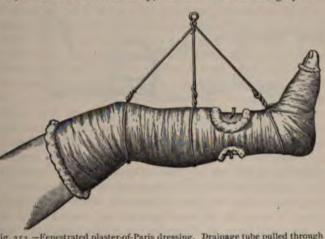
Fig. 252.—Fracture-hook inserted in displaced fragment (McBurney and Dowd).

Amputation is demanded when the limb is completely crushed or pulpified through its entire thickness; when extensive pieces of skin are torn off; when the main artery, vein, and nerve are torn through; and sometimes when there is violent hemorrhage from a deep-seated

vessel or when an important joint is splintered. What is to be done is to some extent determined by the patient's age and general health. In a healthy young

person, if in doubt, give the limb the benefit of the doubt and try to save it; if the artery alone is ruptured, cut down upon it and tie both ends; if the vein alone is torn, suture it, apply a lateral ligature, or tie both ends; if the nerve is severed, suture it; if a joint is opened, drain and asepticize. If an attempt is made to save the limb, be ready at any time to amputate for gangene, secondary hemorrhage (if re-ligation at original point and compression high up fail), extensive cellulitis, and profuse and prolonged suppuration.\* When it is determined to try to save the limb, the part must be cleansed thoroughly by the antiseptic method (in no injuries is this more important). If a small portion of bone protrudes, cleanse the skin of the extremity and the protruding bone, push the spicule out a little more and cut it off. If a large piece of bone is protruded, it must not be cut away, but should be thoroughly dis-

infected, and after the skin wound has been enlarged should be returned into place. Hemorrhage requires a free incision to permit of ligation of bleeding points. In comminuted fractures, fragments which are completely should be re-



broken off Fig. 253.-Fenestrated plaster-of-Paris dressing. Drainage tube pulled through

moved, but those which are only partially separated should be retained. In all cases a drainage-tube must be carried down to the seat of fracture, and in some cases a counter-opening must be made and the tube be pulled through the limb (Fig. 253).

After inserting the tube the wound is sutured, a plentiful antiseptic dressing is a pplied, and the extremity is dressed with plaster. The plaster can be applied over a narrow strip of wood, trap-doors or fenestra being cut in the plaster before it sets (the jenestrated splint) (Fig. 253). The wound is then covered

with gauze and a bandage.

The bracketed splint is a better dressing than the one just described. After wound has been dressed with gauze, plaster is at once applied over the ends of brackets (Fig. 254). The above methods not only immobilize the fractured been so, but keep the parts aseptic and afford easy access to the wound. The drainage-tubes are usually removed, if suppuration does not occur, in from y-eight to seventy-two hours. The wound is treated as any other wound. In some compound fractures there is difficulty in retaining the fragments in apposition (lower end of femur, upper third of femur). In such cases the ends of the bone should be resected and the bones should be fastened together as in

<sup>\*</sup> See Howard Marsh on "Fractures," in Heath's Dictionary of Practical Surgery.

a case of united fracture, with silver wire, aluminum wire, chromicized catgut, or kangaroo-tendon. In a compound jracture of the patella after free incision and disinfection, investigate to determine the gravity of the injury. In an ordinary case in which there are two or three fragments, open the joint, irrigate with saline fluid, drill the fragments, and fasten them with silver wire. Very small fragments should be removed. A tube is carried into the joint, the wound is sutured and dressed, and the limb is immobilized in extension. In a case of severe compound comminuted fracture of the patella, after disinfection, the loose piece should be removed and "the remaining portions made smooth with bone forceps and the sharp spoon."\* The wound is only partially sutured, is drained and dressed, and the limb is placed on a straight

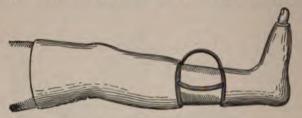


Fig. 254. - Bracketed plaster-of-Paris dressing.

posterior splint. If a fracture of a rib is compound internally, resect the rib; if it is compound externally, dress antiseptically.

Compound fractures may be followed by gangrene, slough-

ing, periostitis, septicemia, pyemia, osteomyelitis, necrosis, etc.

Operative Treatment of Recent Fractures.—In some fractures reduction and fixation are only possible by operation. The operative treatment grows in popularity and should be employed oftener than it is. In most cases an incision is made, the bone is inspected, tissue intervening between the fragments is removed, and the fragments are coaptated and fixed by screws and a perforated plate, by silver wire sutures, by nails, or by some form of clamp.

Treatment of Delayed Union and Ununited Fracture.—When delayed union exists, seek for a cause and remove it, treating constitutionally if required, and thoroughly immobilizing the parts by plaster. Orthopedic splints may be of value. Use of the limb while splinted, percussion over the fracture, and rubbing the fragments together, thus in each case producing irritation, have all been recommended. Blistering the skin with iodin or firing it has been employed. If the union be very long delayed, forcibly separate the fragments and put up the limb in plaster as we would a fresh break. If these means fail, irri-



Fig. 255.—Parkhill's clamp for ununited fracture.

tate by subcutaneous drilling or scraping, or, better, by laying open the parts and then drilling and scraping at many places. Buechner advocates the induction of hyperemia by a constricting band, just as Bier induces congestive hyperemia in treating tuberculous areas. At first the constriction is permitted to remain but a short time, but the period is lengthened every day,

\* Lilienthal's "Imperative Surgery."

until in a few days it remains almost continuously day and night. He claims that ten days of almost continuous application cures most cases. Helferich devised this method in 1887. In several cases I have thought that it did good, and I also administered thyroid extract to these patients. Lannelongue and Menard inject a 1:10 solution of zinc chlorid between the fragments. Leaving acupuncture needles in for days is approved by some, and electropuncture is advocated by others. Cases of ununited fracture must be treated by excision of the bony ends and fibrous tissue, securing the fragments together by periosteal sutures, by pins, by screws and plates, by ivory pegs, by screws, by silver or aluminum bronze wire, by kangaroo-tendon, by Senn's bone-rings or bone-ferrules, or by chromicized catgut. Delorme makes an incision, removes bone-splinters and fibrous tissue, smooths off one end, forces this into the bored-out medullary canal of the other fragment, and sutures the periosteurn. Gussenbauer's clamp will often give a good result, and was used for years by Billroth. This is a metal bar with two nails set at right angles to the One nail is driven into each fragment. Langenbeck fixed a screw into each fragment and connected the screws by a piece of iron. Parkhill's clamp 255), which is an improvement on Langenbeck's instrument, secures absolute immobility and is a very useful instrument (see Osteotomy for Ununited Fracture). In some fractures a very small incision is made in the skin and the fragments are nailed together (transcutaneous fixation Roberts calls it). I believe that the following closed fractures should be treated by opera tion:

Fractures of the clavicle with sharp ends which are liable to punch through the skin or damage important structures.

So me fractures of the mandible.

Fr ctures of the zygoma.

Some fractures of the metacarpus.

So the fractures of the bones of the forearm.

So e fractures about the elbow-joint.

All fractures of the olecranon.

Most fractures of the patella.

Many fractures of the surgical neck of the humerus.

Po L's fracture.

Fracture of the upper third of the femur.

So e fractures of the neck of the femur in the young and middle aged.

Fractures of the os calcis.

Treatment of Vicious Union.—If angular deformity results from faulty union—it can be corrected by moulding the part into shape while the callus is soft.—If the callus has become hard, the bone can be refractured. If faulty

union occurs with overriding, an osteotomy can be performed.

Special Fractures.—Nasal Bones.—The nasal bones, because of their situation, are often broken. The commonest seat of fracture is through the lower third, where the bones are thin and lack support. The fracture is usually compound externally or through the mucous membrane internally. The cause is direct violence. Displacement may not occur at all, but when present it arises purely from force, and never from muscular action, no muscle being attached to these bones. If the force is from the front, the nose is flattened; if from the side, it is deflected. Displacement is soon masked by swelling. Crepitus can sometimes be elicited by lightly grasping the upper part of the

nose with the fingers of one hand and moving it gently below from side to side with the fingers of the other hand. Preternatural mobility is valueless as a sign, because of the natural mobility of the cartilages. Nose-breathing is difficult because of blocking of the nostrils by blood-clot. Diagnosis may be almost impossible when deformity is absent.

The complications that may be noted are cerebral concussion, brain-symptoms from implication of the frontal bone or cribriform plate of the ethmoid bone, and extension of the fracture to the superior maxillary or lachrymal bones. Emphysema of the root of the nose, the eyelids, and the cheeks is common, and means either a rent in the mucous membrane of Schneider or a crack in the frontal sinus. There may be much discoloration because of subcutaneous hemorrhage. Epistaxis is usual, and is recognized from the epistaxis produced by fracture of the base of the skull by the facts that the bleeding in the first condition is profuse, is, as a rule, soon checked, and is not followed by oozing of cerebrospinal fluid, whereas in the second condition it is profuse, continued, and followed by a flow of cerebrospinal fluid. Fracture of the bony septum occasionally complicates nasal fractures, and deviation of the cartilaginous septum often takes place. Suppuration may occur and necrosis of bone or cartilage may follow. The prognosis is usually good.

Treatment.—After cocainizing the nares a careful inspection should be made by means of a mirror and a light to determine if there is any injury of the septum. This point must be determined in order that the deformity of the septum may be corrected at the same time as is the deformity of the nasal bones. When there is no displacement, or when a displacement does not tend to be reproduced after reduction, employ no retentive apparatus of any kind. Order the patient not to blow his nose for ten days and syringe it daily with a solution of bicarbonate of sodium. If deformity be noted, correct it at once, as the bones soon unite in deformity. If the attempts at reduction are very painful, or if the subject be a child, a woman, or a nervous man, give ether to obtain primary anesthesia. Reduction is effected by a grooved director or steel knitting-needle wrapped in iodoform gauze and passed into the nostril; the fragments are lifted with this instrument, and the fingers externally mould them into place. A rubber dilator can be used in reduction. This is pushed into the nose and inflated by air or water. If the septum is deviated and can-



Fig. 256.-Mason's pin.

not be pushed in place by a metal sound, it must be twisted into place by means of septum forceps. If bleeding is moderate, check it with cold; if severe, by plugging. "For fractures high up with displacement, gauze packing carried well up will be required to retain the elevated bones. For lower deviations the Asch tube will be needed" (Scudder, on "The Treatment of Fractures"). A hollow vulcanite plug is inserted in each nostril and the nose is moulded into correct shape over the plug. The patient breathes through the hollow plug. A thread runs from each plug and is fastened to the cheek by adhesive plaster. Once or twice a day the plugs are

removed, cleaned, and greased with iodoform ointment. The nose is cleared, and the plugs are reinserted. If flattening tends to recur, pass a Mason pin

(Fig. 256) just beneath the fragments, through the line of fracture and out the opposite side. Steady the fragments by a piece of rubber externally caught on each end of the pin, or with figure-of-eight turns around the ends with silk. Leave the pin in place for five days. The instrument of Mason is a sharp, strong, nickel-plated pin, with a triangular point.

If lateral deformity tends to recur, hold a compress over the fracture or fix a moulded-rubber splint over the nose by a piece of rubber plaster one and a half inches broad and long enough to reach well across the face, and use com-

pression for ten days. In neither of the above cases is the nose to be blown, and in both cases it is to be syringed once or twice a day. In fractures rendered compound by tears in the mucous membrane irrigate with normal salt solution or boracic-acid solution, holding the head so that the solution will not run into



Fig. 257.-Jones's nasal splint.

the mouth; plug with iodoform gauze around a small rubber catheter, which instrument permits nose-breathing; carefully remove the gauze daily and syringe. In fractures compound externally cleanse antiseptically externally, and dress with a film of cotton soaked in iodoform collodion or compound tincture of benzoin, or apply sterile gauze. Fractures of the bony septum, if showing a tendency to reproduction of deformity, require packing as above explained or the use of a special splint within the nostrils (Fig. 257), or the application of vulcanite plugs, so made that the patient can breathe through them, and that threads can be attached to them. Fractures of the nasal cartilages are to be pinned in place. Fractures of the nose are entirely united in from ten to twelve days.

Fractures of the Lachrymal Bone.—The lachrymal bone may be broken when the nasal bones, a superior maxillary bone, or the lateral plate of the ethmoid are fractured, and union is solid in from three to four weeks. The question of how much deformity is to be expected is always uncertain, and in not a few cases obstruction of the nose follows fracture because of damage to the septum.

Treatment.—Treat the chief injury, which is the fracture of the other bone or bones. Maintain the patency of the lachrymal duct by frequently passing a clean probe.

Fractures of the Superior Maxillary Bone.—Although a fragile bone, the superior maxillary is rarely broken except through the alveolar border. It may be broken by transmitted force from blows on the chin, or on the head when the chin is fixed; but direct violence is the usual cause. The wall of the antrum may be crushed in. Comminution is the rule, and the injury is often compound. These fractures induce great swelling, pain, and inability to chew. Mobility and crepitus may be detected. Deformity is due to the breaking force, and not to the action of any muscle. When a portion of the alveolar arch is fractured, as may occur in pulling teeth, the small fragment is depressed backward, and there exist irregularity of the teeth (some of which may be loosened) and inability to chew food. Fracture of the nasal process is apt to injure the lachrymal duct. When the antrum is broken in there are great sinking over the fracture, depression of the malar bone, and emphysema. Transverse fracture of the upper part of the body of the bone may

cause no deformity. The force required to break the superior maxillary bone is so great that fractures of other bones almost certainly occur, and concussion of the brain not infrequently exists. Injury of the infra-orbital nerve is not unusual, causing pain, numbness, or an area of anesthesia involving one-half of the upper lip, the ala of the nose, and a triangle whose base is one-half the upper lip and whose apex is the infra-orbital foramen. There is also loss of sensation in the gums and upper teeth of the injured side. Fractures of the superior maxillary bone occasionally induce fierce hemorrhage from branches of the internal maxillary artery; and if this occurs, watch for secondary hemorrhage (these vessels being in firm canals).

Treatment.—If the fracture does not implicate the alveolus, or if no deformity exists, apply no apparatus, but feed the patient on liquid food for four weeks. Reduce deformity, if it exists, by inserting a finger in the mouth. If the antrum is broken in, put the thumb in the mouth and push the malar bone up and back. In certain cases of deformity make an incision at the anterior border of the masseter muscle, insert a tenaculum or aneurysm needle, and pull the bone into place (Hamilton). If the malar bone or malar



Fig. 258.—Hard-rubber splint; wire arms and chin-piece held together by metal rods and nuts.

process is driven into the antrum, Weir tells us to incise the mucous membrane above and external to the canine tooth of the upper jaw, break into the antrum with a bone-gouge, insert a steel sound, lift out the malar bone, and pack the antrum with gauze. Loose teeth are not to be removed; they are pushed back into place and held by wiring them to their firmer neighbors. Hemorrhage is arrested by cold and pressure. If hemorrhage is dangerously profuse or prolonged, tie the external carotid.

If the line of the teeth, notwithstanding the wiring, is not regular, mould on an interdental splint. The usual splint for the upper jaw is the lower jaw held firmly against it by the Gibson, the Barton, or the four-tailed bandage. There is a great amount of dribbling ot saliva during the treatment, and a dressing must be used to catch this fluid. Every day remove the bandage and dressing, and wash the face with ethereal soap. The patient, who is ordered not to talk, is to live on liquid food administered by a nasal tube or by pouring it into the mouth back of the last molar tooth by means of a tube or a feeding-cup. Never pull a tooth to obtain a space; but if a tooth is lost, utilize the

bone. If correction is impossible by ordinary methods and the movements of the lower jaw are impeded by the displaced bone, make a small incision and through this insert an instrument and endeavor to lift the bone into place. As these cases are almost invariably complicated by fracture of the upper jaw, they are treated in the same manner as the latter injury. The union is complete in three weeks.

Fractures of the zygomatic arch are very rare. The causes are (1) direct violence; (2) indirect force (from depression of the malar); and (3) forcing foreign bodies through the mouth. Direct violence is the usual cause. Direct violence causes inward displacement, and indirect force may cause outward displacement. The usual seat of fracture is at the smallest portion of the process—that is, on the temporal side of the temporomalar suture (Matas). The symptoms are pain, ecchymosis, swelling, displacement, and difficulty in moving the jaw (because of injury to the masseter muscle).

Treatment.—In simple fracture give ether and try to push the arch in place. Many surgeons do not make an incision, as depression will do no harm and the functions of the jaw will be restored. Simply dress with a compress, adhesive strips, and the crossed bandage of the angle of the jaw. Union will take place in three weeks. Matas\* advises operation. An anesthetic is administered, and the parts are asepticized. A long semicircular Hagedorn needle is threaded with silk, is entered one inch above the middle of the displaced fragment, is passed well into the temporal fossa, and is made to



Fig. 200.-Hard-rubber splint in position, upper teeth resting upon it (Moriarty).

emerge half an inch below the arch. The silk is used to pull a silver wire around the fracture, and this wire is employed to pull the bone into position. A firm pad is applied externally and the wire is twisted over the pad. Anti-

<sup>\*</sup> New Orleans Med. and Surg. Jour., Sept., 1896.

septic dressings are applied, and on the ninth or tenth day the wire, splint, and dressings are removed permanently. I have employed this plan in two cases with perfect satisfaction.

Fractures of the inferior maxillary bone may, and most usually do, affect the body, although they occasionally occur in the rami. Any part of the body may be fractured, the most usual seat being near the canine tooth or a little external to the symphysis (Pick). A portion of alveolus may be broken off. In fractures of the ramus either the angle, the condyloid neck, or the coronoid process may be broken. In fractures of the body the posterior fragment generally overrides the anterior. Fractures of the lower jaw are often multiple and are almost always compound, because the oral mucous membrane and alveolar periosteum are torn. The cause is usually direct violence. Indirect violence (lateral pressure) may fracture the body anteriorly. Fractures near the angle are always due to direct violence. Indirect violence may fracture the condyle (falls on the chin), and so may direct violence. Fractures of the coronoid process are very rare, and they arise from great direct violence (usually a gunshot-wound or some other penetrating force).

Symptoms.—In fracture of the body preternatural mobility and crepitus generally exist. The gum over the fracture swells rapidly and decidedly. There is bleeding because of laceration of the gum; saliva dribbles constantly; after two or three days some of the cervical lymph-glands enlarge; when the fracture is open through the mucous membrane suppuration is usual; the odor of decomposition soon becomes marked; the patient supports the jaw with the hand; great pain exists (possibly from injury of the nerve); and deformity is present, shown by inequality of the teeth if the fracture is anterior to the masseter, the anterior fragment going downward and backward and the posterior fragment going upward and forward. The downward displacement is due to muscular action (action of the digastric, geniohyoid, and geniohyoglossus). The backward displacement is due to the violence. The temporal, internal pterygoid, and

masseter muscles draw the posterior fragment upward and to the front. In fracture of the neck of the condyle the jaw is drawn toward the injured side, and the condyle is pulled inward and forward by the action of the external pterygoid muscle. In fracture of the coronoid process the temporal muscle pulls the small fragment upward.

Complications.—The complications are—digestive disorders and diarrhea from swallowing foul discharges; loosening of the teeth; lodgment of loosened teeth between the fragments; bleeding (usually only oozing from the gum, but there may be hemorrhage from the inferior dental artery); and suppuration. Necrosis may follow these fractures, an abscess of the neck may develop, or a sinus may form.



Fig. 261, -Hamilton's bandage.

Treatment.—Remove a tooth if it lies between the fragments, but replace

it in its socket after reducing the fracture. Correct deformity with great care and be sure to bring the teeth into normal alinement. As a rule, push loose



Fig. 262.—Vulcanite splint with boxes vulcanized on each side. If the jaw is fractured in the region of the molars, considerable pressure is required to get the parts in position; therefore it is best to vulcanize on to the sides of the vulcanite splint boxes into which wire arms can be inserted (Pilcher).

teeth into place and put back detached ones; but occasionally a tooth obstinately prevents perfect approximation, and if it does it must be removed. Wash the mouth with hot water to clean it and to check bleeding. If bleeding is very severe, compress the carotid artery for a time. The fracture can be dressed with a pad of lint over the chin and Hamilton's fourtailed bandage (Fig. 261, A common plan is to take a splint of pasteboard, felt, or gutta-percha; pad it lightly with cotton, mould it to the part, and hold it in place with a Barton or a Gibson bandage. If apposition of the fragments cannot be maintained by the above methods, fasten the teeth together with wire, wire the

fragments together, or have a dentist apply an interdental splint (Figs 262, 263). Fracture of the lower jaw can often be most satisfactorily treated by Angle's bands. These bands are of great value in complicated cases, in which two or more fractures exist. Each band consists of thin metal and a screw and a nut to fit the screw. The band is adjusted around a firm tooth and a nut is applied so as to hold the band tightly. Several bands are placed upon teeth in both jaws. Silver wire or silk is thrown around the pins of the bands so as to catch, and the jaws are thus held firmly together. The patient is to be fed on liquid food (see Fracture of the Upper Jaw), the mouth is

to be washed frequently with peroxid of hydrogen, followed by boric acid solution or normal salt solution, and if bandages were used they should be changed every second day. The union should be complete in five weeks. The best plan of treatment in all of these cases is to send the patient to a capable dentist and have him apply an interdental splint and direct the treatment. Though these fractures are usually compound, they do not endanger life.



Fig. 263.-Interdental splint.

Fractures of the Hyoid Bone.—These

fractures are uncommon injuries, and are caused by hanging, by throttling, and by falls in which the neck strikes some obstacle. If the bone breaks by throttling, it is its body which fractures (indirect force). Fractures by muscular action are most unusual.

Symptoms.—The symptoms are: A sensation of something breaking; bleeding from the mouth if the mucous membrane be lacerated; pain, which is worse on opening the jaws or on moving the head or tongue; difficulty in swallowing; muffled, hoarse voice or aphonia; swelling, and frequently ecchymosis, of the neck. There are observed occasionally, though rarely, harsh

cough and dyspnea, irregularity of bony contour, and crepitus. Always look into the mouth and see if there can be detected ecchymosis or laceration of the mucous membrane or projection of a bony fragment. The displacement is due to the middle constrictor of the pharynx contracting. A fracture of

the hvoid bone may destroy life.

Treatment.—For dyspnea, be ready to perform intubation or tracheotomy at a moment's notice. Edema of the glottis is a great danger. Try to restore the fragments with one hand externally and with a finger in the mouth. Put the patient to bed and have him lie back upon a firm rest so that his shoulders are elevated. His head is to be placed between extension and flexion, a pasteboard splint or collar is moulded on the neck, and a bandage is applied around the forehead, neck, and shoulders to keep the head immobile. The patient must not utter a word for a week; he must at first be fed by enemata, and then for some time on liquid diet, which is given through a tube early in the case. Endeavor to control the cough by opiates. A fractured hyoid bone requires about four weeks to unite.

Fractures of laryngeal cartilages are caused by direct violence, as throttling, blows, or kicks. They are rare in young persons, and are commonest when the cartilages have begun to ossify. They are very grave injuries, death tending to occur from obstruction to the entrance of air.

Symptoms.—The symptoms, which are severe, are pain, aggravated by attempts at swallowing or speaking; swelling, ecchymosis it may be, and emphysema of the neck; cough; aphonia; intense dyspnea; and bloody expectoration if the mucous membrane is ruptured. There can be detected inequality of outline (flattening or projection) and perhaps moist crepitus.

The usual seat of the injury is the thyroid cartilage.

Treatment.—Cases without dyspnea require quiet, avoidance of all talking feeding with a stomach-tube, the application of compresses and adhesive strips over the fracture, and the use of remedies to quiet cough. The surgeon must be ready to operate at any moment. In most cases dyspnea exists, due to projection of the fragments or submucous extravasation. When there is dyspnea, emphysema, or spitting of blood, at once practise intubation, or, if unable to do this, open the larynx or trachea below the seat of fracture. If laryngotomy or tracheotomy is performed, try to restore to proper position displaced fragments. If the fragments will not remain reduced, introduce a Trendelenburg cannula or a tracheotomy-tube, and pack gauze around it. Take out the packing in four days, and remove the tube as soon as the patient breathes well, when the opening may be allowed to close. In these cases feed with a stomach-tube and keep the patient absolutely quiet. Union takes place in four weeks.

Fractures of the Ribs.—The ribs, owing to their shape, elasticity, and mode of attachment, readily bend and as readily recover shape, and thus withstand considerable force without breaking. Notwithstanding these facts, the situation of the ribs so exposes them that in 16 per cent. of all cases of fractures noted by Gurlt these bones were involved. In children fracture of a rib seldom occurs and is usually incomplete; it is common in adults and the aged, and in them is generally complete. It is more frequent among men than among women. The ribs commonly broken are from the fifth to the ninth, the seventh being the one that most frequently suffers. Fracture

of the first rib alone is an excessively rare accident. The eleventh and twelfth ribs are seldom broken. A rib may be broken in several places, and several ribs are often broken at the same time. Fracture of a single rib is not nearly so common as fracture of several ribs. These fractures may be compound either through the skin or through the pleura, a damaged lung permitting pneumothorax. Compound fractures are very rare, however, except from bullet-wounds.

Causes.—Direct force, as buffer accidents, kicks, blows with heavy instruments, or being jumped on while recumbent, may produce these injuries. A fracture from direct violence occurs at the point struck, and the ends, projecting inward, may damage a viscus. Indirect force, as great pressure or blows which exaggerate the natural bony curves, tends to produce fractures near the middle of the ribs or in front of their angles and to force the ends outward. A number of ribs are apt to be broken. Muscular action, as in coughing, sneezing, lifting, or parturition, occasionally, but very rarely, is a cause.

Symptoms.—In connection with the history of the accident the symptoms are: acute localized pain (a stitch) on breathing, increased by pressure over the seat of pain, pressure backward over the sternum, cough, and forcible inspiration or expiration; respiration is largely diaphragmatic, the patient endeavoring to immobilize the injured side; cough is frequent and is suppressed because of pain. Crepitus is often but not invariably found. The surgeon seeks for it, first, by resting the palm of his hand over the seat of pain while the patient takes long breaths; second, by placing a thumb before and one behind the seat of pain and making alternate pressure; and third, by auscultation. It should be remembered that incomplete fractures are the rule in children; hence in them do not expect crepitus. Deformity is usually trivial unless several ribs are broken, because shortening cannot occur and the intercostal attachments prevent vertical displacement. Preternatural mobility may occasionally be elicited, when the region is not deeply covered with muscles, by pressing on one side of the supposed break and observing that a part of, and not the entire, rib moves. If air gathers in the subcutaneous tissue and there is no wound of the surface, it is proof of rib fracture with lung damage. In such a case the lung has been penetrated by a fragment, and air has been forced out into the tissues. This condition is recognized by great and growing swelling, which crackles when touched. Such a collection of air is known as cellular emphysema. Bloody expectoration suggests lung injury; bloody expectoration and cellular emphysema, without an external wound, prove injury of the lung. A simple, uncomplicated case of fracture of a rib or ribs in a young person gives a good prognosis.

The complications are: additional injury, making the fracture externally or internally compound; laceration of the pleura, pericardium, heart, lung, diaphragm, liver, spleen, or colon; rupture of an intercostal artery; hemothorax; cellular emphysema; pulmonary emphysema; pneumothorax; pyothorax; traumatic pleurisy; pneumonia; bronchitis; congestion or edema of the lungs.

Treatment.—In an uncomplicated case the patient is not kept in bed, as breathing is easier when erect than when recumbent. Angular displacement outward is corrected by direct pressure. Displacement inward is soon cor-

rected, as a rule, by the expansion of ordinary respiratory action; but if it is not thus corrected, etherize, the deep breathing of the anesthetic state almost always succeeding. If ether fails, and dangerous symptoms come on, incise under strict antiseptic precautions, elevate, and drain, or sometimes resect a portion of the rib.

After correcting any existing deformity immobilize the injured side. Direct the patient to raise his arms above his head, to empty his chest of air by a forced expiration, and to keep it empty until a piece of rubber plaster (two inches wide) is forcibly applied seven or eight inches below the fracture and from the spine to the sternum. The patient is now allowed to take a breath and is directed to empty the chest again, another piece of plaster being applied, covering the upper two-thirds of the width of the first strip. This process is continued until the side is strapped well above and well below the fracture (Pl. 6, Fig. 13). Over the plaster light turns of a spiral bandage of muslin are carried, or a figure-of-8 bandage of the chest is applied, the turns crossing over the seat of injury. About once a week the plaster is removed and fresh pieces applied after rubbing the chest with soap liniment, drying, and anointing excoriations with an ointment of oxid of zinc. The dressing is worn for three or four weeks. The patient avoids cold, damp, and draughts. The diet must be nutritious but non-stimulating, and any cough should be treated by opiates and expectorants. A person with this injury who has reached the age of sixty must take stimulant expectorants (ammonii carb., gr. x, in infus. senegæ, 3ss, t. i. d.) or employ a steam-tent several times a day. The old method of treatment, in which the chest was included in a forcibly applied broad rib-roller, is not to be used except as a temporary expedient; it compresses the entire chest, causes pain and dyspnea, and tends to loosen and slip.

Fracture of the ribs complicated with visceral injury is highly dangerous, and requires confinement to bed. The treatment is that of the visceral injury. If there be bloody expectoration, apply adhesive strips as above indicated, put the patient to bed reclining on a bed-rest, keep him quiet, subdue the circulation, and employ opium, diaphoretics, and expectorants (a good mixture consists of squill ipecac, ammonium acetate, and chloroform; opium is given separately). Inflammations of the lung or the pleura, fortunately, are apt to be localized, and are treated as are ordinary inflammations of these parts. If signs of pulmonary injury are severe from the start or become worse under medical treatment, incise, resect a rib, arrest hemorrhage, and drain the pleura. In laceration of an intercostal artery incise and try to ligate; if unable to ligate, resect a rib and apply a ligature. If the signs point to internal bleeding, resect a rib, search for the bleeding point, and ligate. Emphysema usually soon disappears; but if it does not, make many small incisions in the cellular tissue, dress antiseptically, and employ pressure. When there arises a sudden attack of dyspnea, which is prone to happen in these cases, and in which the face becomes blue, the heart labors, and suffocation seems imminent, bleed the patient almost to syncope.

Fractures of the costal cartilages are not common, even in the aged. Such fractures occur either through the cartilages or through their points of junction with the ribs. These injuries generally arise from direct violence, the cartilage of the eighth rib being most prone to suffer. Bennett, of Dublin, has seen over 25 specimens of fracture of the first costal cartilage. Indirect

force (such as a blow upon the shoulder) is occasionally the cause, but when it is the cause some other injury besides the fracture of the cartilages is apt to be noticed. Muscular action is a possible cause.

Symptoms.—Displacement is often absent; but if present, it is forward or backward of either fragment, and is due chiefly to the force of the injury, but partly, it may be, to muscular action. When displacement is absent, crepitus will not often be found; in fact, crepitus is usually absent in these injuries. Localized pain, swelling, and ecchymosis are noted. Preternatural mobility may or may not be detected. Union by bone is to be expected.

Treatment.—If displacement exists, try to reduce it. If the fragment is displaced backward, reduce by deep inspirations; if the fragment is displaced forward, reduce by pulling back the shoulders. In this attempt failure is the rule, and the surgeon may then adopt Malgaigne's expedient of applying a truss over the projection for a day or two. Dress and treat the case as if a rib were broken, removing the dressings in four weeks.

Fractures of the Sternum.—The sternum may be broken, along with the ribs and spine, from great violence. Fractures of the sternum alone are infrequent, because the bone rests on a spring-bed of ribs. Fractures of the sternum may be simple or compound, complete or incomplete, single or multiple. The most usual injury is a simple transverse fracture at or near the gladiomanubrial junction, at which point dislocation may also occur. Both fracture and separation of the ensiform cartilage are very rare. The sternum may be broken along with the ribs or clavicle.

Causes.—These are: direct force, as by a fall of an embankment or of a wall, by a car-crush, or by the passing of a cart-wheel over the body; indirect force, as by a fall upon the head, thus driving the chin against the chest; by a fall upon the feet, the buttocks, or the shoulder; by forced flexion or extension of the body over an edge or angle (as may occur during labor-pains).

Symptoms.—In fracture of the sternum displacement is not always present, but when it does occur the lower fragment is apt to pass forward; displacement may, however, be transverse or angular, or there may be overriding. The posterior periosteum, which rarely tears, limits displacement, but some deformity can, as a rule, be detected. The history of the nature of the accident has a valuable bearing upon the question of diagnosis. The position assumed by the patient is with the head and body bent forward, as attempts to straighten up cause much suffering. There is fixed and localized pain, increased by deep respiratory action, by body-movements, or by cough. Crepitus is sought for by auscultation and by placing the hand over the injury and directing the patient to make quick respirations. Mobility may become manifest on external pressure, during respiration, or while attempts are being made to bring the body erect. Respiration in these cases is usually much interfered with. It is not important to separate diagnostically diastasis from fracture.

Complications.—Other fractures generally complicate fracture of the sternum, and laceration of the pleura or pericardium and hemorrhage into the anterior mediastinum may exist. Abscess of the mediastinum and necrosis of the sternum may appear as late consequences. The prognosis is good in uncomplicated cases.

Treatment.—The deformity attending fracture of the sternum is to be corrected, if possible, by external pressure. If overriding is found, effect

reduction by bending the body back over a firm pillow and ordering the patient to respire deeply; if this method fails, give ether and then bend the body backward. The deformity, after reduction, tends to recur, but the bones unite well even in deformity, and no great harm results. The fragments need not be cut down on or be hooked up unless there be internal injury. After reducing the deformity, cover the front of the chest with adhesive strips extending laterally from one axillary line to the other, and covering a region from above the fracture down to the ensiform cartilage. Place over this covering an anterior figure-of-eight bandage of the chest. In some cases, where deformity recurs after reduction, a circular bandage of the chest is applied and the shoulders are pulled strongly back with a posterior figure-of-eight bandage. The plaster is to be reapplied once a week. Some surgeons treat these cases by means of a large compress held by adhesive plaster and a broad tight roller.

The patient goes promptly to bed, and reposes erect, or semi-erect, on a bed-rest. This position favors easy respiration and antagonizes the tendency to displacement. The diet should be light, nutritious, and non-stimulating. Convalescence is established in four weeks, and the plaster should be permanently removed in five weeks. When the ensiform cartilage is so bent in as to cause intense pain or to injure the stomach, it should be exposed by incision and resected. Edema of the skin and fever, if they appear, indicate pus, in which case an incision should be made at the edge of the sternum and the pus-cavity should be irrigated and drained.

Fractures of the Pelvis.—In some of the indicated fractures serious

injury of the pelvic contents is apt to be found.

Fractures of the False Pelvis.—Fractures of this region are seldom dangerous unless comminuted. There may be fracture of the iliac crest or of the anterior superior spine, or the line of fracture may traverse the entire length of the flanged-out ilium, or the bone may be comminuted with the association of grave visceral damage. The anterior superior and posterior superior spines may be broken off.

Causes.—The cause of fracture of the false pelvis is generally violent direct force, as the passage of a wagon-wheel, the fall of a wall, the kick of a horse or mule, or the force of car-crushes. Violent contraction of the rectus femoris muscle may tear off the anterior inferior spine of the ilium.

Symptoms.—In fracture of the false pelvis the history of violent force is noted. The patient leans toward the injured side. Pain exists, which is aggravated by movements (particularly by bending forward), by coughing, or by straining to empty the bowels or the bladder. Ecchymosis and swelling are manifest. Crepitus and preternatural mobility are detected by moving the iliac crest. Deformity is very rarely present. Cases uncomplicated by visceral injury make good recoveries.

Complications.—The fracture may be, but rarely is, compound, as the parts are well protected with muscles. The colon may be injured when

comminution has taken place.

Treatment.—If there are symptoms of injury of the colon, perform laparotomy, search for the injured region, and suture it. In treating an ordinary fracture of the false pelvis put the patient on a fracture-bed, raise the shoulders, and apply a canvas binder about the pelvis, or encase the pelvis with broad pieces of rubber plaster, or employ the belt or girdle. The pressure of the binder, girdle, or plaster must not be so great as to force the fragment of ilium inward. Place the knees over two pillows so as to semiflex the legs and thighs, and tie the knees together. To restrain thigh-movements it may be necessary to encase a restless patient with splints or bind him to sandbags. If the pelvic binder displaces the fragments or causes pain, abandon it and trust to position. If the fragment cannot be retained in place, wire it. The dressings can be removed in six weeks, and the patient is allowed to get up in eight weeks. In simple, uncomplicated fracture of the false pelvis the prognosis is good. In compound fractures of the false pelvis asepticize, drain and dress, put on a binder, and direct the same position to be maintained as for simple fractures.

Fractures of the True Pelvis.—The most usual seat of these fractures is through the obturator foramen, the ascending ischial and horizontal pubic rami being broken. A fracture may occur near the symphysis pubis, the symphysis may be separated, a line of fracture may run near to or into the sacroiliac joint, the same may involve each side of the body of the pubis, and there may be multiple fractures. Fractures of the acetabulum and of the tuberosity of the ischium may occur. Before the seventeenth year the innominate bone may be broken into its three anatomical segments. Fractures of the true pelvis are highly dangerous because of the damage which is apt to be inflicted on the pelvic contents. There may be rupture of the bladder or membranous urethra and injury of the vagina, the rectum, the uterus, or the small gut. The cause of pelvic fracture is violent force, direct or indirect. Front force tends to produce direct, and side force indirect frac-

ture. The acetabulum may be broken by falls upon the feet.

Symptoms.—In pelvic fracture there is a history of violent force. There are great shock, ecchymosis which is possibly linear, swelling, and intense pain increased by attempts at motion, coughing, and straining. There is also inability to sit or to stand. Mobility becomes obvious on grasping an ilium in each hand and moving the hands. Crepitus may be noticed by this maneuver or by moving an ilium with one hand, a finger of the other hand being inserted in the rectum or vagina. In making movements for diagnostic purposes be very gentle, as rough manipulation may cause injury by sharp fragments. There may be doubt as to whether crepitus is to be referred to pelvic fracture or to fracture of the neck of the femur; in this case follow the rule of John Wood: "The surgeon grasps the femur with one hand and places the other firmly upon the anterior superior iliac spine or crest or upon the pubes; then, on moving the femur and abducting it freely, if a crepitus be detected, it will be felt the more distinctly by that hand which rests on or grasps the fractured bone."

Rupture of the bladder is made manifest by pain in the hypogastric region, an intense desire to micturate, an inability to pass urine in quantity although a few drops of bloody urine may be voided, great shock, sometimes dulness on percussion in the loins, and evidences of extravasation in the prevesical space. The condition is proved to exist by practising the maneuvers suggested under Rupture of Bladder. The symptoms of ruptured urethra are set forth later. Bleeding from vagina or rectum points to laceration of the part by a fragment. The vagina may be badly lacerated and the bowels may emerge from the laceration (Maurice H. Richardson's case).

Intestinal injury is apt to induce septic peritonitis. Fracture of the brim of the acetabulum permits dorsal dislocation of the femur to occur, which dislocation will not remain reduced, and causes shortening, which at once recurs when extension is abandoned—inversion and adduction, although the power of eversion and abduction is preserved (Stokes). There is crepitus, and the head of the bone goes with the fragment upward and backward (Stokes). If the head of the femur be driven through the acetabulum into the pelvis, the injury is very grave; there are then found shortening, adduction, and semiflexion of the thigh, absence of the prominence of the great trochanter, and more capacity for movement than is noted in dislocation. Fracture of the ischium rarely occurs alone.

Treatment.—Examine carefully to determine if the bowel, the bladder, the urethra, or the vagina is injured. If such an injury exists, radical operation is of course demanded. Always use a catheter to see if the urine is bloody. Bloody urine suggests, but does not prove, the existence of a ruptured bladder. It may be due to simple contusion of the bladder or to contusion of the kidney. In treating a pelvic fracture endeavor to restore the parts to a normal position, employing external manipulation and inserting a finger in the rectum or in the vagina. If reduction is difficult, administer ether. The pelvis should be encircled with a canvas binder and the patient should be placed upon a Bradford frame. If this is done he can be cleaned readily and the bed-pan can be easily used. If movements of the thighs distort the pelvic bones, each thigh should be bound to the frame. In fracture with separation of the pubic bones, the bones should be wired together. If urinary extravasation occurs, perform perineal section. If there are signs of bowel injury or intraperitoneal rupture of the bladder, perform laparotomy; and if the bladder is found to be torn, apply sutures. All visceral injuries are treated by general rules. Remove the dressings in six weeks and allow the patient to get about in twelve weeks. In fracture of the acetabulum, if the limb is shortened, give ether and reduce by extension and counterextension. Treat these fractures in the same way as intracapsular fractures of the femur. Fractures of the ischium are best treated by the application of a pad and adhesive plaster, and rest in bed.

Fractures of the Sacrum.—This bone may be broken by direct force, such as a kick, but the injury is rare. The sacral plexus is usually injured, and if it is paralysis is observed in the territory of its branches.

Symptoms.—The symptoms of fracture of the sacrum are pain, frequently incontinence of feces and retention of urine, irregularity of the sacral spines, ecchymosis, and crepitus. Crepitus may be sought for with one hand externally and a finger of the other hand in the rectum. The lower fragment passes forward and may obstruct or may tear the rectum. Paralysis may be found in the area of distribution of the sacral plexus.

Treatment.—In any case of fracture of the sacrum if there are evidences of pressure upon nerves by displaced bone, incise and elevate the depressed bone. If the rectum is lacerated sutures must be inserted. In many cases of fracture of the sacrum the older conservative treatment is sufficient. The conservative treatment is as follows: Press the fragments into place with a hand externally and a finger in the rectum. Do not plug the rectum. Put a pad over the upper fragment, hold it with plaster or a binder, place the patient recumbent on a fracture-bed, and insert a large cushion

underneath the pad. Some surgeons give opium to induce constipation, and allow a fecal support to accumulate in the rectum. Use a clean catheter regularly, and guard against bed-sores. Union occurs in about four weeks, when the dressing can be removed. The patient can get about again in six weeks. If urinary retention persists or if intractable bed-sores form after eight or ten weeks, cut down on the seat of injury and elevate or remove the portion of bone causing pressure.

Fractures of the Coccyx.—The coccyx may be broken or be separated from the sacrum by a fall, a blow, a kick, or the straining of parturition.

Its mobility is so great, however, that it does not often break.

Symptoms.—The chief symptom of fracture of the coccyx is pain, which is much aggravated by sitting, walking, or straining at stool. If the index finger is inserted into the rectum, the displaced bone is felt; if the thumb of the same hand is also placed externally, a rocking motion will develop crepitus and preternatural mobility.

Treatment.—In treating fracture of the coccyx reduce by external pressure and by the manipulations of a finger in the rectum and put the patient to bed. In four weeks the fracture should be united. If union does not take place, defecation and all movements of the coccyx will cause excruciating pain by pressure on the last sacral nerve. This condition, known as "coccygodynia," demands a subcutaneous division of the nerve or of the muscles which move the coccyx, or a resection of the bone.

Fractures of the Vertebra. (See page 871.) Fractures of the Skull. (See page 807.)

Fractures of the Clavicle.—The clavicle is more often fractured than any other bone. The fracture may occur at any age, but is commonest before the sixth year (Hulke says one-half of the recorded cases). It may be simple, multiple, comminuted, oblique, transverse, complete, incomplete, or, very rarely, compound. Both clavicles may be broken. Fractures are most apt to occur just external to the middle, at the point where the inner or large curve meets the outer or small curve, at which junction the bone is at its smallest diameter. Fractures of the acromial end are more frequent than fractures of the sternal end, and less frequent than fractures of the shaft. The causes of fracture of the clavicle are direct violence, indirect violence, and, very rarely, the contractions of "the deltoid and clavicular fibers of the great pectoral" (Treves, from Polaillon).

Fractures of the shaft are usually due to indirect violence, as falls upon the shoulder or upon the outstretched hand. In the latter accident, which is the usual mode of origin, the concussion of the fall travels up and the body-weight travels down, and these two forces compress the bone, which snaps at its weakest point. Fractures from indirect force are oblique, and in children are of the green-stick form. Fractures from direct force are usually transverse, and are occasionally comminuted. Fractures from muscular action have been recorded (Rubini the tenor, recorded by Melay).

Symptoms.—In fracture of the shaft of the clavicle the attitude of the patient is peculiar. He supports the elbow or wrist of the injured side with the hand of the sound side, and also pulls the extremity against the chest; the head is turned down toward the shoulder of the damaged side, as if trying to listen to something in the joint, thus relaxing the pull of the sternocleidomastoid muscle upon the inner fragment. The shoulder is nearer the

sternum, on a lower level, and farther front than that of the sound side. Loss of function is shown by inability to abduct the arm, and in many cases by inability to place the hand on the top of the erect head. Considerable pain exists, which is increased by motion, by pressure, and by hanging down the extremity without support.

The deformity above noted is described by stating that the shoulder goes downward, inward, and forward (D. I. F.). The downward deformity is chiefly due to the weight of the extremity, which pulls down the unsupported outer fragment, and is contributed to by the action of the pectoralis minor muscle. The inward deformity is chiefly due to the contraction of the pectoralis minor and subclavius muscles assisted by the action of the pectoralis major. The jorward deformity is due to rotation of the outer fragment, which is brought about by the serratus magnus muscle carrying the scapula forward. In this deformity, the inner end of the outer fragment is below and behind the outer end of the inner fragment, which overrides it. The inner fragment, though pulled on by the sternocleidomastoid muscle and relatively higher than the outer fragment, is really but little, if at all, elevated, marked elevation being prevented by the attachment of the rhomboid ligament. After noting the deformity, detect with the finger the irregularity of bony contour. Examine for preternatural mobility and crepitus by raising and throwing back the shoulder. In looking for these signs in children it is to be remembered that the fracture is probably incomplete. The prognosis is good, the bone uniting, but always with some shortening and inequality.

Complications.—Fractures of the shaft are rarely compound, because the sharp end of the outer fragment passes backward and because of the free play the skin makes over the bone (Pickering Pick). Both clavicles may be broken. One or more ribs may be fractured at the same time. In fractures from direct force deeper structures may be injured by fragments. Thus, injury of the brachial plexus will induce paralysis. There are 11 recorded

cases of simple fracture of the clavicle complicated by laceration of a large vessel. Eight of these cases died. The vessel ruptured may be the subclavian vein, the subclavian artery, or the jugular vein. After a rupture a huge blood-clot forms (Gallois and Piollet, in "Rev. de Chir.," July and Aug., 1901).

Treatment.—In treating a fracture of the shaft of the clavicle correct the deformity as soon as possible by throwing the shoulder upward, outward, and backward. If the patient is a girl, it is desirable to minimize the deformity. Place her upon her back upon a hard bed, with a small pillow under her head, a firm and narrow cushion between the



Fig. 264.—Fox's apparatus for fractured clavicle.

shoulders, a bag of shot resting over the seat of fracture, and the forearm lying on the front of the chest, the arm being held to the side by a sandbag. In three weeks there will be union, practically without deformity.

In a child with an incomplete fracture a handkerchief sling for the forearm, worn three weeks, is all that is needed. In a fracture of the collarbone of an adult the Velpeau bandage is efficient. Before applying it, place lint around the chest and cotton over the elbow. Change the bandage



Fig. 265.—Sayre's adhesive-plaster dressing for fracture of the clavicle (Stimson): A, First piece; B, second piece.

every day for the first week, and after that period every third day. Each time it is changed rub the skin with alcohol, ethereal soap, or soap liniment, dry carefully, and examine for excoriations; if any are found, they are anointed with zinc ointment before the dressing is reapplied. The dressing is permanently removed at the end of four weeks, the arm being carried in a sling for another week. The classical apparatus of Desault is now rarely used. The posterior figure-of-eight bandage associated with the second roller of Desault, some turns being made from

the elbow of the injured side to the shoulder of the sound side, can be used in cases in which the forward deformity is apt to return. The apparatus of Fox, which is very useful, consists of a pad for the axilla, a sling for the forearm, and a ring for the opposite shoulder, to which ring are tied the tapes from both the pad and the sling (Fig. 264).

The dressing of Moore, of Rochester, is valuable in an emergency. It consists of a piece of cotton cloth, two yards long, and folded like a cravat until it is eight inches in width at the middle. The center of the bandage rests upon the elbow, the posterior tail is carried across the front of the shoulder of the injured side. The forearm is at an acute angle with the arm, and the other end of the bandage is carried across the forearm, across the back over the opposite shoulder, and around the axilla, where the extremities are stitched together. The forearm is suspended in a bandage sling (S. D. Gross). The four-tailed bandage is preferred by Pick. Sayre's dressing has many advocates (Fig. 265), For this there are required two pieces of rubber plaster, each piece being three inches wide and sufficiently long to go around the chest one and a half times. The end of one piece encircles the arm of the injured side just below the arm-pit; the plaster strip is pulled across the back to the other side, to the front of the chest, and returns again to the middle of the back. This procedure pulls the elbow back and throws the shoulder out. The hand of the injured side is placed on the breast of the opposite side, cotton being interposed, and the second strip of plaster runs from the elbow of the injured side and the opposite shoulder, front, around, and back, pressing the elbow forward, upward, and inward. In children, if it is found difficult to immobilize the parts, the most satisfactory result is obtained by the application of the Velpeau bandage, which is to be overlaid by a thin plaster-of-Paris bandage. If the fragments cannot be coaptated, sterilize the parts, administer ether, incise, clear away the muscle from between the fragments, saw the ends, bore each end and hold them in contact by means of kangaroo-tendon or silver wire. The same procedure should be pursued when a fracture is compound or threatens to become so, or if signs indicate pressure upon vessels or nerves. If a large vessel has been injured, the operation is imperatively necessary. If a patient suffering under a fracture which threatens to become compound refuses the aid of operation, keep him in bed and hold the arm in abduction. In five cases in the Jefferson Medical College Hospital the author wired the fragments with excellent results. Year by year I become more inclined to recommend wiring in cases of fractured collar bone. It secures union without deformity, saves the vessels and nerves, and obviates the necessity of prolonged and very uncomfortable fixation of the arm and forearm.

After a broken collar-bone has united, if the shoulder is found to be stiff, make passive movements daily; if these fail, move the joint forcibly, first giving ether or nitrous oxid.

Fractures of the acromial end of the clavicle are due to direct force. If the fracture is between the two coracoclavicular ligaments, deformity is very slight, crepitus is elicited by manipulating with the fingers, and pain exists, but loss of function is not markedly manifest unless it is due to pain. These fractures are treated by interposing cotton between the arm and the side, binding the arm to the side with the second roller of Desault, and hanging the hand in a sling. In fractures external to the ligaments crepitus is manifest on moving the shoulder, the outline of the bone is irregular, severe pain is developed by movement, and deformity is pronounced. The deformity is due to the serratus magnus muscle rotating the scapula forward, the inner end of the outer fragment of the clavicle often coming in contact with the anterior surface of the outer portion of the inner fragment. Fracture of the acromial end of the clavicle is reduced by pulling both of the shoulders strongly backward, and it is kept reduced by the use of a posterior figure-of-eight bandage. In fracture external to the ligaments the displacement frequently cannot be corrected by position and manipulation. Such cases demand incision and wiring. In either variety of fracture the dressings are worn for four weeks.

Fractures of the sternal end of the clavicle are very rare. They are caused by either direct or indirect force. In such a fracture there are found crepitus, projection at the seat of fracture, rigidity of the sternocleidomastoid muscle, and shortening of the clavicle. The inner end of the outer fragment always passes forward, and often also downward and inward. Reduce these fractures by pulling the shoulders back, and treat them by means of the posterior figure-of-eight bandage worn for four weeks. Wiring may be necessary.

Fractures of the Scapula.—This bone is not often broken, as it rests upon thick muscles and elastic ribs; it is freely movable, and it has attached to it a bone which easily breaks.

Fractures of the Body of the Scapula.—These are due to direct violence. The symptoms are pain (which becomes agonizing on attempting to rotate the shoulder-blade), ecchymosis, and swelling. Crepitus is sought for by placing the hand over the bone and making movements of the arm; also by holding the point of the shoulder and lifting up the lower angle of the bone. The latter plan may develop mobility. The spine of the scapula is uneven only when it is itself fractured. Examine for unevenness of the vertebral border of the shoulder-blade. In fractures of the body of the scapula a shoulder-cap is ap-

plied, a gutta-percha splint is molded over the scapula, the arm is bound to the side, and the hand is carried in a sling. The apparatus is worn for four weeks.

Fractures of the spine of the scapula are treated as are fractures of the body of the bone, and for the same time.

Fractures of the Neck of the Scapula.—Fracture of the anatomical neck has not been proved to exist. Fracture of the surgical neck is evinced by flattening of the shoulder, prominence of the acromion, and the presence of a lump in the axilla, crepitus being developed by pressing the axillary prominence upward and backward. The coracoid process descends with the humerus. The deformity is reduced with ease, but it at once recurs. The condition is treated by placing a pad in the axilla, a shoulder-cap on the shoulder, applying the second roller of Desault, and supporting the forearm and elbow in a sling. A Velpeau dressing can be used, associated with the application of a folded towel in the axilla. The dressing is to be worn for five weeks.

Fractures of the glenoid cavity are not very unusual, and may occur with or without dislocation. Fracture of this region arises from direct force applied to the shoulder. The existence of this fracture is determined by excluding fractures of other bones and by detecting crepitus when the arm is at a right angle to the body and the humerus is pushed against the glenoid cavity, the crepitus not being found when the arm hangs by the side.

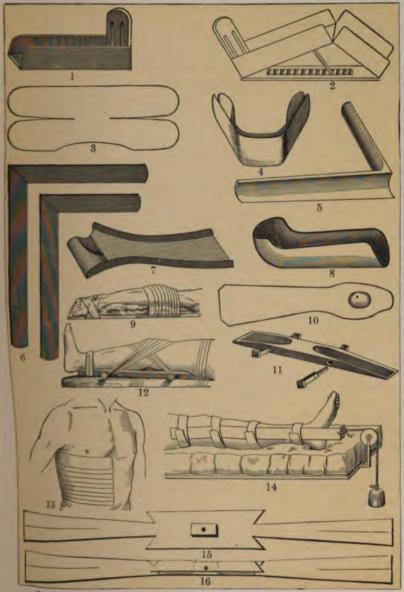
Treatment is by the second roller of Desault and a forearm sling worn for four weeks; careful passive movements limit ankylosis. If ankylosis occurs, adhesions must be broken up while the patient is under ether or nitrous oxid.

Fractures of the acromion process are often met with as the result of direct violence. The existence of fracture of the acromion is indicated by pain, by inability to abduct the arm, by flattening of the shoulder, by sudden lowering of the point of the shoulder, by mobility, and by crepitus. To treat a case of this kind, put a large pad in the axilla with the base down, bind the arm over the pad with the second roller of Desault, lifting the elbow with turns of the roller carried over it and the opposite shoulder, thus splinting the bone in place by the head of the humerus pushing against the coraco-acromial ligaments. The dressing is to be worn for four weeks.

Fractures of the coracoid process rarely happen alone, and may arise from direct force or from muscular action. But little displacement is found. Crepitus and mobility are usually detected. Inability to shrug the shoulder inward was pointed out as a symptom by Byers. Such a case is well treated by a Velpeau bandage, which is to be worn for four weeks.

Fractures of the humerus are divided into (1) fractures of the upper extremity; (2) fractures of the shaft; and (3) fractures of the lower extremity. In examining any fracture of the humerus, feel at once for the pulse, so as to ascertain if the artery has been torn; in any fracture near the head of the humerus be certain that dislocation does not exist.

Examination of the Shoulder.—In some cases ether must be administered. Compare the injured shoulder with the sound shoulder, the patient, if not anesthetized, being seated in a chair or stool. The direction of the axis of the arm is noted. The surgeon grasps the flexed elbow with one hand



\* Fracture-box. 2. Double Inclined Plane Fracture-box. 3. Jaw-cup (unfolded). 4. Jaw-cup (titled). 5. Anterior Angular Splint. 6. Internal Angular Splint. 7. Bond Splint. 8. Shoulder-cap. 7. Dupayren Splint in Pott's Fracture. 10. Agnew Splint for Fracture of the Metacarpus. 11. Agnew Splint for Fracture of the Patella. 12. Agnew Splint applied. 13. Strapping the Chest in Fractured Rola. 14. Extension Apparatus in Fracture of the Femur. 15, 16. Adhesive Strips for Extension Apparatus.



and the shoulder with the other; he thus can move the extremity and palpate the joint and adjacent points. The shoulder is moved gently in every direction, and the surgeon notes if the head of the bone moves with the shaft. Examination shows if the head of the bone is in place or if the glenoid cavity is vacant—if the head of the bone is in an abnormal situation, if it is altered in contour, if there is crepitus or preternatural mobility, and if any movement is impaired. The acromion process, outer end of the clavicle, coracoid process of the scapula, and neck of the scapula are also investigated. The length of the arm is obtained by measuring from the apex of the acromion process of the scapula to the apex of the external condyle of the humerus, and it is compared with the length of the sound extremity.

1. Fractures of the upper extremity of the humerus include (a) fractures of the anatomical neck; (b) fractures of the surgical neck; (c) fractures of the head, oblique and longitudinal; and (d) separation of the upper

epiphysis.

Fractures of the Anatomical Neck of the Humerus.—The anatomical neck is the constricted circumference of the articular surface, and fractures of it, though rare, do occur, especially in the aged. The line of fracture in some cases follows the insertion of the capsule, in others it is entirely within the capsule, but in most it is without the capsule above and within the capsule below; hence the term "intracapsular" is rarely correct as a designation. Such a fracture may be impacted. The cause is direct violence or a fall or a blow upon the elbow when the arm is abducted. Polloson, of Lyons,\* has reported a case due to muscular action. The patient died in eclampsia, and at the necropsy it was found that both humeral heads were fractured and impacted. The fractures must have been produced by the muscles throwing the heads of the bones violently against the glenoid cavities, probably by adduction.

Symptoms.—The symptoms in fracture of the anatomical neck are pain, swelling, ecchymosis, slight irregularity of the shoulder (which irregularity is soon hidden by tumefaction), and inability to actively abduct the arm. Deformity, as a rule, is slight or is absent, because the capsule is rarely entirely torn from the lower fragment. If deformity exists, it is due to the muscles inserted on the bicipital groove and to the coracobrachialis, which pull the lower fragment inward and forward. Treves says that a tear of the reflected fibers of the capsule leads to subsequent necrosis, because this joint has no ligamentum teres. In unimpacted cases there is crepitus, and mobility of the shaft can be detected near the head of the bone. In some cases impaction occurs, the upper fragment impacting into the lower. In this condition there are very slight shortening and trivial shoulder-flattening, no crepitus unless the tuberosity is broken off, no mobility, and, as Erichsen says, the head of the bone, while it can be felt through the axilla, is not in the axis of the limb.

The prognosis of fracture of the anatomical neck is usually good for bony union (Hamilton, Pick, and R. W. Smith), but a stiff joint is apt to result.

Treatment.—Feel the pulse to be sure the artery is untorn. In most cases an anesthetic should be given in order to examine with ease and dress

<sup>\*</sup> Rev. de Chir., vol. viii, 1888.

with satisfaction. Sometimes the fragments are readily coaptated; occasionally they are not. In a case reported by Carl Beck the axes of the fragments were at right angles and they could only be kept in contact by holding the arm at a right angle to the body ("New York Med. Jour.," April 5, 1902). Some surgeons treat this fracture by simply hanging the wrist in a sling and suspending a bag of shot from the elbow to make extension. The usual plan of treatment is as follows: flex the arm to a right angle with the body, and carry up from the base of the fingers to above the elbow the turns of



Fig. 266,—Fracture at upper end of the humerus. Note hand, forearm, and elbow bandaged; axillary pad and strap, plaster-of-Paris shoulder-cap, sling (Scudder).



Fig. 267.—Fracture at upper end of the humerus. Arm and elbow bandaged. Axillary pad and shoulder-cap in position. Application of circular bandage to trunk and shoulder. Sling not shown (Scudder).

a spiral reversed bandage made of flannel. Interpose lint between the arm and the side, and place a V-shaped pad with the apex upward in the axilla. tying the tapes over the opposite shoulder. A shoulder-cap made of pasteboard (Pl. 6, Fig. 8) or plaster-of-Paris (Fig. 266), moulded to fit and well lined with cotton, is applied. The plaster-of-Paris cap is the most satisfactory. It is applied "so as to cover the whole shoulder, the anterior and posterior aspects of the chest and the outer side of the upper arm down to the external condyle of the humerus" (Scudder, on "The Treatment of Fractures") (Fig. 266). The arm with the shoulder-cap is fixed to the side by the second roller of Desault, and the wrist is hung in a sling (Fig. 267). The edges of the bandage should be stitched together. This apparatus is changed daily for the first few days, the body and arm being rubbed at each change with alcohol, soap liniment or ethereal soap. After this period a change every third or fourth day is often enough. Massage is begun at the end of one week, but rotation and motion of the joint are not employed until after three

weeks. The dressings are removed at the end of four weeks, the forearm being carried in a sling for two weeks more. In impacted fracture do not pull apart the impaction, do not use a pad, but apply a cap to the shoulder and fix the arm to the side for five weeks. The fracture unites with deformity.

Fractures of the Surgical Neck of the Humerus.—The surgical neck is the constricted portion of bone between the tuberosities and the upper

line of the insertion of the muscles on the bicipital groove. Fractures in this region are usually transverse, but they may be oblique. The causes are: direct force almost always; indirect force occasionally; and muscular action in rare instances.

Symptoms.—The symptoms in fracture of the surgical neck are: pain running into the fingers from pressure upon the brachial plexus; crepitus and mobility on extension; and flattening, which differs from the flattening of dislocation in that it occurs farther below the acromion and that this process is not so prominent. Shortening to the extent of an inch is noted. The head of the bone can be felt in the glenoid cavity, but it does not move on



Fig. 268.—Internal angular splint and shoulder-cap in fracture of the surgical neck of the humerus.

rotating the arm. The upper end of the lower fragment is felt and moves on rotating the arm. The displacement is pronounced. The lower fragment is pulled upward by the deltoid, biceps, coracobrachialis, and triceps; inward by the muscles of the bicipital groove; and forward by the great pectoral; thus, the upper end of the lower fragment projects into the axilla, and the elbow lies from the side and backward. Péan holds that the violence drives the lower fragment forward. The upper fragment is abducted and rotated outward, which position is due, it is generally taught, to the action of the supraspinatus, infraspinatus, and teres minor muscles. In some cases displacement is forward, and in other cases it is not obvious. The lower fragment may impact into the upper, in which case the symptoms are obscure and the diagnosis is made by exclusion. If the impaction is solid and complete, there are the history of direct force, the impaired movements, the slight deformity, and the absence of crepitus. In all fractures of the upper end of the humerus the distinction can be made from dislocation by feeling the head of the bone under the acromion and by noting that it does not move on rotating the

The prognosis of fracture of the surgical neck of the bone is good.

Treatment.—Some surgeons treat a fracture of the surgical neck in exactly the same manner as a fracture of the anatomical neck. We prefer the following plan: In many cases give ether in order to examine and dress. Feel the pulse to see that the artery has not been damaged. Reduce by traction and manipulation; if there is an impaction, pull it apart. Take an internal angular splint (Pl. 6, Fig. 6) and pad it well, putting on extra padding at the points that are to rest against the palm, the inner condyle, and

the axillary folds. Lay the arm and pronated forearm upon the splint. Apply a padded shoulder-cap. Fix the splint and cap in place with a spiral reversed bandage terminating as a spica of the shoulder, and hang the hand or forearm in a sling (Fig. 268) The dressing is to be worn for four weeks, and the rules to be followed in changing it are the same as in fracture of the anatomical neck. Massage is used after one week and passive motion after four weeks to amend stiffness. In rare cases—those with strong anterior projection of the lower end of the upper fragment—apply an anterior angular splint. In some cases where the deformity strongly tends to recur support by a plaster-of-Paris trough on the back and sides of the arm and shoulder (Fig. 269), or maintain extension by weights and pulleys, the patient



Fig. 269.—Apparatus for fracture of the humerus at any point above the condyles.

being kept in bed (Stimson). I have reached the conclusion that many cases of fracture of the surgical neck are best treated by incision and fixation.

Longitudinal and Oblique Fractures of the Head of the Humerus.—By this term may be designated separation of the great tuberosity or separation of a portion of the articular surface, together with the great tuberosity, from the shaft and lesser tuberosity (Pickering Pick, Guthrie, and Ogston). The cause is usually direct violence to the front of the shoulder, but the greater tuberosity may be torn off by muscular action.

Symptoms.—The symptoms in longitudinal and oblique fracture of the head are broadening and flattening of the shoulder with projection of

the acromion. The upper fragment passes upward and outward, and the lower fragment passes upward and inward to rest on the margin of the glenoid cavity below the coracoid process. The elbow is drawn from the side, there is some shortening, and the patient cannot abduct his arm. If the surgeon grasps the patient's elbow and holds it to the side and rotates the arm while with his other hand he grasps the upper fragment, crepitus is very positive. Examination develops wide separation of the fragments. The deformity cannot be entirely corrected, because the biceps tendon usually gets between the fragments (Ogston), but a useful limb can usually be obtained.

Treatment.—The plan which gives the best result in treating longitudinal and oblique fracture of the head of the bone is to place the patient on his back upon a hard bed with a small, firm pillow under his head, abduct the arm above the head, rotate it outward so that the back of the hand rests on the bed, and hold it in place by sand-bags. This position should be maintained for three weeks, at the end of which period the fracture can

be treated for three weeks more as is a fracture of the anatomical neck. If the patient refuses to go to bed, treat the injury as a fracture of the anatomical neck, padding well over the tuberosities. The dressings should be worn for five weeks, passive motion being made after four weeks. In the above injury feel at once for the pulse, to see if the artery has been torn.

Separation of the Upper Epiphysis of the Humerus.—The epiphysis is united during the twentieth year. Separation is a rare accident and is

produced by direct force.

Symptoms.—The chief symptom in separation of the upper epiphysis is projection of the upper end of the lower fragment inward, forward, and upward beneath the coracoid, and consequently a projection of the elbow backward and from the side. If the lower fragment passes forward and not inward, the elbow simply passes back. The upper end of the lower fragment is smooth and convex. Rotation of the shaft develops soft crepitus when the fragments are in contact.

The prognosis is good for bony union, though the future growth of the limb may be impaired.

Treatment.—The treatment for separation of the upper epiphysis is a pad in the axilla, a shoulder-cap, binding the arm to the side, and hanging the hand in a sling. Wear the dressing for four weeks, and begin passive motion as directed when dealing with fracture of the upper end of the humerus.

2. Fractures of the Shaft of the Humerus.—Fracture of the shaft of the humerus is a very common accident. The cause is usually direct violence, such as a blow. The fracture may arise from indirect violence, such as a fall upon the elbow. Muscular action is not rarely also a cause, as in throwing a ball, in catching a tree-limb while falling, or in turning another's wrist outward as a test of strength (Treves). This test of strength is known by the French as "le tour de poignet."

The opponents sit opposite to each other and each rests his elbow on a table. They clasp hands and each one strives to rotate the other's hand outward. Ashhurst collected 57 cases due to throwing a ball and 23 cases due to "le tour de poignet." He believes that in some cases the humerus is broken as a stick may be broken by holding one end and swinging the other through the air and that in other cases fracture results from twisting (Astley P. C. Ashhurst, in "University of Penn. Med. Bulletin," Feb., 1906). In fracture due to muscular action the break is nearly always below the deltoid insertion and the

line of fracture approaches the transverse.

The symptoms of fracture of the shaft of the humerus are pain, swelling, ecchymosis, inability to move the arm, mobility, and distinct crepitus. Shortening to the extent of three-fourths of an inch occurs. The displacement varies with the situation of the fracture and the direction of the force. If the fracture is above the insertion of the deltoid, the lower fragment is pulled up by the triceps, biceps, and deltoid, and pulled out by the deltoid, and the upper fragment is pulled inward by the arm-pit muscle. In fracture below the deltoid this muscle is apt to pull the lower end of the upper fragment outward, while the lower fragment passes inward and upward because of the action of the biceps and triceps. Injury of the musculospiral nerve

sometimes occurs. The nerve may be contused, producing pain at the seat of bruising, and tingling and numbness in the region supplied by the nerve.



Fig. 270.—Fracture of the shaft of the humerus. Note bandage to hand, forearm, and elbow; axillary pad and strap; coaptation splints and sling. Bandage does not cover fracture (Scudder).



Fig. 271.—Fracture of the shaft of the humerus. Note bandage to hand, forearm, and elbow; adhesiveplaster swathe holding arm upon axillary pad and covering coaptation splints. Sling (Scudder).

In most cases the symptoms soon pass away, but sometimes neuritis ensues. A severe contusion produces not only pain, but paralysis of the muscles

supplied by the nerve, and surface anesthesia. In most cases this condition is recovered from in a few weeks, but sometimes it lasts a long while or even permanently. In musculospiral paralysis the patient is unable to extend the wrist and fingers or to supinate the forearm. There is "complete loss or impaired sensation in the lower half of the outer and anterior aspect of the arm and in the middle of the back of the forearm as far as the wrist" (Scudder, in "The Treatment of Fractures"). The nerve may be divided by a sharp fragment, paralysis of motion and anesthesia resulting at once. In some cases the nerve is caught in and compressed by callus, scar-tissue, or fragments, motor and sensory disturbances resulting.

The prognosis is good, but the fact should always be remembered that ununited fractures are commoner in the humerus than in any other bone. Treves believes this to be due to entanglement of muscle between the fragments, lack of fixation of the shoulder-joint, and imperfect elbow-support. Hamilton believes that it is due to the facts that the elbow soon becomes fixed at a right angle, and that any movement of the forearm moves the seat of fracture and not the elbow.

Treatment.—It is rarely necessary to anesthetize unless the patient be a nervous woman or an excitable child. Feel the pulse, to be certain the artery

has not been lacerated. Reduce the fracture by extension, counterextension, and manipulation. Apply four humeral splints. The internal splint reaches from the axilla to just above the internal condyle of the humerus. A short straight splint is applied front and another back, each being the length of the arm. A shoulder cap is applied, which cap "is prolonged below into an external angular splint reaching as far down as the lower third of the forearm." ("Manual of Surgical Treatment," by Cheyne and Burghard). The elbow is brought to a right angle with the arm and the forearm is placed midway between pronation and supination. As Cheyne and Burghard say: "It is necessary that the arm should hang vertically at the side with the long axis of the forearm parallel



Fig. 272.—Preliminary splinting for complete dressing as shown in Fig. 269.

with the anteroposterior diameter of the trunk; if the forearm be brought at all lorward across the chest, rotation of the lower fragment upon its vertical axis is apt to take place." Splints are to be worn for five or six weeks, and after the removal of the splints the wrist is hung in a sling. The sling is dispensed with eight weeks after the infliction of the injury. Passive movements are not to be made until the fracture is well united (after five or six weeks), for, if made too soon, they predispose to non-union, and, as no joint is involved, genuine ankylosis will not occur. Many surgeons treat these fractures by applying plaster of Paris to the forearm and the arm (the elbow being flexed to a right angle), binding the arm to the side, and hanging the wrist in a sling. Others apply a trough to the arm and forearm (Fig. 269). Scudder prefers to bandage the hand, forearm, and elbow, and apply an axillary pad, coaptation splints, a swathe of adhesive plaster holding arm to the side, and a sling (Figs, 270, 271). In any case in which is is impossible to obtain and maintain correct apposition.

of the fragments, cut down upon them, and apply sutures. If the nerve is divided, an incision must be made, and the nerve sutured and the bone wired. If the nerve is caught in the callus, after repair has taken place the nerve must be liberated by chiseling the callus away. Neuritis is treated by blisters over the nerve, the use of the descending galvanic current, and the administra-

tion of salicylate of ammonium and the bromids.

3. Fractures of the Lower Extremity of the Humerus.-These fractures are spoken of as fractures in, or in the neighborhood of, the elbowjoint, and they include (a) fractures of the external condyle; (b) fractures of the internal condyle; (c) fractures of the internal epicondyle; (d) fractures at the base of the condyles; (e) T- or Y-shaped fractures; (f) epiphyseal separation; and (g) fractures of the capitellum and trochlea. There may be more than one fracture, or there may be also a dislocation of the humerus, of the ulna, or of both bones. Rarely the fracture is compound. These fractures are frequent injuries in childhood, and are not uncommon in adults.

Method of Examination.-A fracture of the elbow is rapidly followed by great swelling, and the diagnosis is often very difficult. In most cases, when possible, the x-rays should be used in arriving at a diagnosis. In every case in which the x-rays are not used, and in most cases in which they are, the surgeon examines the parts carefully while the patient is under ether. If swelling is very great, it is necessary to abate it in order to reach any conclusion as to the condition. We can bandage the arm, rest it semiflexed on a pillow, and apply evaporating lotions or even an ice-bag for a day or two, or, what is better, temporarily diminish the swelling by Gerster's plan, which is as follows: Apply an Esmarch bandage from the hand to well above the seat of fracture; this will drive away extra-articular swelling and permit of thorough examination. It is a great advantage to have the patient anesthetized, for then not only can we make an accurate diagnosis, but we can reduce the fracture satisfactorily and apply a careful first dressing.

Compare the injured with the sound elbow. Note swelling and local ecchymosis. Feel the radial pulse. Note the "carrying angle" (Fig. Measure each arm from the tip of the acromion process of the scapula to the tip of the external condyle of the humerus. Feel each prominent body-point and note if it is mobile (condyles, olecranon, head of ulna). Feel the shaft just above the condyles. Mark with ink on each elbow the tip of the external condyle, the tip of the internal condyle, and the tip of the olecranon, and observe the relation between these points of each elbow in flexion and in extension. In an uninjured elbow a straight line transverse to the long axis of the limb with the joint in extension will pass through the condyles and leave the tip of the olecranon just a shade above it. "When the elbow is at a right angle, these three points will be found in the same plane with the back of the upper arm" (Scudder, in "The Treatment of Fractures"). Rotate the radius while a thumb is held against the head of the bone. Make flexion and extension of the elbow and determine if there is any lateral motion. Test for mobility just above the condyles, The above maneuvers will determine the presence or absence of crepitus, preternatural mobility, deformity, etc.

Fractures of the External Condyle of the Humerus .- A fracture of the external condyle runs into the joint and the capitellum is usually broken

off. Such an injury occurs oftenest in children, being due to falling on the hand; but it may occur from direct force, and may happen to adults.

Symptoms.—The symptoms of fracture of the external condyle are severe pain, great swelling, and crepitus (found on pressing or moving the condyle and on rotating the radius). Mobility may also be discovered. A projection is felt on the outer and posterior surface of the elbow. The forearm is semi-flexed and supinated. The patient cannot use the joint.

Fractures of the Inner Epicondyle of the Humerus.—The inner epicondyle is an epiphysis which unites during the seventeenth year. It not infrequently breaks from muscular action or from direct violence, and the fracture does not involve the joint. Crepitus and mobility can be detected. Displacement is slight. The outer epicondyle is never fractured alone.

Fractures of the Internal Condyle of the Humerus.—The line of fracture after a break of the internal condyle runs into the joint, to the trochlear surface of the humerus. The cause is nearly always direct violence. Packard, of Philadelphia, observed a case in which the condyle had been torn off while lifting a tub.

Symptoms.—In fracture of the internal condyle the fragment, accompanied by the ulna, goes upward and backward, and when the forearm is extended



Fig. 273.-Loss of carrying function after fracture of inner condyle of the humerus,

the ulna projects posteriorly, the lower end of the humerus being felt in front. The fragment forms a projection back of the elbow. Crepitus and preternatural mobility can be found if swelling is not too great. Crepitus is detected by flexing and extending the forearm. The space between the condyles is broader than normal, and the forearm takes a bend toward the ulnar side, the "carrying function" of the forearm being lost (Fig. 273). When a person carries a heavy object, such as a bucket, he instinctively rests

the inner condyle upon the pelvis, and the normal deviation of the forearm outward keeps the bucket from striking the leg. This deviation outward when the inner condyle rests against the ilium gives us the carrying function. In fracture of the inner condyle the broken condyle ascends and the "carrying function" is lost (Fig. 274).

Fractures at the Base of the Condyles of the Humerus.—A fracture in this region is just above the olecranon and is on a higher level behind than in

front. The cause is direct force acting upon the olecranon.

The symptoms are loss of function and pain from injury of the median or ulnar nerve. Crepitus and mobility are readily found. The lower fragment is drawn backward and upward by the action of the triceps, biceps, and brachialis anticus muscles. The lower end of the upper fragment projects in front of the joint. This lesion may be mistaken for dislocation of the bones of the forearm backward. In fracture the limb is mobile; in dislocation it is rigid. In fracture the deformity is easily reduced and strongly tends to recur; in

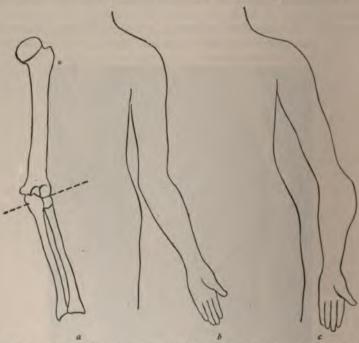


Fig. 274.—Diagram to exhibit the "carrying function" of the forearm, and the loss of this function in fracture of the inner condyle of the humerus: a and b show the normal relation of the parts when carrying; c shows the alteration of axis of the forearm when the inner condyle is fractured, what is known as gunstock deformity resulting (after Allis).

dislocation the deformity is reduced with difficulty and does not tend to recur. In dislocation there is shortening of the forearm, but not of the arm; in fracture there is shortening of the arm but not of the forearm. In dislocation there is a smooth, large projection below the crease in front of the elbow; in fracture there is a sharp projection above the crease. In fracture there is crepitus; in dislocation there is no crepitus.

The diagnosis can usually be settled by the Röntgen rays.

T-fractures of the Humerus.—A T-fracture consists of a transverse fracture above the condyles plus a vertical fracture between them. The cause is violent direct force applied posteriorly.

Symptoms.—The symptoms are increase in breadth of the joint (Fig. 275), preternatural mobility, crepitus, pain and swelling, mounting up of the inner condyle back of the elbow on the inner side, and of the outer condyle back of the elbow on the outer side. The forearm is semiflexed and supinated, and the carrying function is lost.

Prognosis of Fractures in or near the Elbow-joint.—In many fractures it is difficult or impossible to obtain reduction, and in some it is impossible to maintain reduction. Stimson is undoubtedly right when he says that "in intercondyloid fracture with marked separation there is no practicable means merely to maintain reduction."\* The prognosis for complete restoration of function is bad, and in most of these fractures some deformity and considerable stiffness are inevitable. Ankylosis partial or complete is a not unusual sequence. Ankylosis may result from prolonged immobilization, the muscles contracting and becoming fibrous, the fascia and ligaments about the joint shortening, the capsule shrinking and thickening, some of the cartilages becoming



Fig. 275.-Deformity following fracture of the humerus between the condyles.

fibrous, and the joint being partly obliterated. It may result from extravasation of blood into the joint and tendon-sheaths with subsequent formation of fibrous tissue. It may arise from organization of inflammatory exudate within and about the joint and in the sheaths of muscles and tendons. It may arise from the formation of an excess of callus. Bruns claims that in fracture in the joint excess of callus rarely forms, and that masses of callus form chiefly in the line of fracture near but not in a joint.† Excessive callus-formation is sure to take place if reduction is not thoroughly accomplished or if the fragments are not well immobilized but move upon each other. A mass of callus in or about a joint limits or prevents motion.

Treatment of Fractures In or Near the Elbow-joint.-Thoroughly set

<sup>\*</sup> Transactions American Surgical Association, vol. ix, † Max Oberst, in Volkmann's "Sammlung Vorträge."

the fracture while the patient is under ether. It is advisable, when it can be done conveniently, to use the x-rays to confirm the diagnosis and to use them again after dressings have been applied, to be sure that the bones remain in good position. If swelling is very great, it may be necessary to delay setting for two or even three days, the arm being bandaged and laid upon a pillow or lightly supported on an anterior angular splint during the waiting period.

In all cases except transverse fracture above the condyles reduction is best effected by drawing upon the forearm, supinating it, extending it, and then bending it slowly into a position of acute flexion, the degree of flexion being in

inverse ratio to the amount of swelling.

In transverse fracture above the condyles reduction is effected by drawing the forearm and the lower fragment downward and forward and at the same time pushing the upper fragment back.

Some surgeons advocate dressing the fracture on an anterior angular splint, the forearm being fully supinated. The advantage claimed for this splint is



Fig. 276.—Anterior angular splint for fractures in or near the elbow-joint.

that if ankylosis occurs the joint is in a position to be useful, which it is not if ankylosed in extension. Some deformity is usually apparent after treating a case with this splint; the deformity following fracture of the inner condyle is not corrected by it, but if the splint is carefully applied the result is usually a useful extremity in all cases except fracture of the inner condyle. In transverse fracture of the shaft of the humerus above the condyles the anterior angular splint is the best method of treatment, as it prevents displacement. The splint must not be applied when

there is great swelling, and swelling must be removed by resting the extremity on a pillow, the elbow being semiflexed, applying evaporating lotions or even an ice-bag, employing massage, and gently compressing by bandaging. In some cases the joint should be aspirated. In order to apply this dressing, take a right-angled splint and pad its outer surface, being careful to place thick, soft pads over the convexity which will press in front of the elbow and over each end of the splint. Fasten the upper end to the arm, then make extension of the forearm, and if the fracture is found to be well reduced, fasten the hand and forearm to the splint (Fig. 276). If the hand and forearm are first fixed to the splint, there will be no extension from the elbow and deformity will result. If posterior projection exists, a pasteboard cup is moulded over the elbow. The extremity is hung in a triangular sling. At night the extremity is kept in the sling or laid on a pillow. Every third or fourth day, while the extremity is carefully steadied, the splint is removed, the arm and forearm well rubbed with alcohol, massaged, and the splint reapplied. The splint is worn between five and six weeks. At the end of the third week, after removing the dressings, slightly flex, slightly extend, and slightly pronate the forearm, and reapply the splint. At the end of the fourth week repeat this maneuver, making movements of greater range. In the middle of the fifth week and at the end of the fifth week do it again, and flex and extend

as much as possible. Very early and very frequent passive motion is objectionable, as it leads to overproduction of callus and ankylosis, but passive motion as above described is imperatively necessary. Many surgeons at the end of the second week apply a Stromeyer splint, which permits the patient and the surgeon to make some motion by means of the screw without removing the dressings. In very stout people an anterior angular splint will not stay in place. In such a case the forearm may be placed at a right angle to the arm and plaster-of-Paris be used. After the dressings are removed employ passive motion, massage, hot and cold douches, inunctions of ichthyol or mercurial ointment, iodin locally, corrosive sublimate and iodid of potassium internally, and direct the patient to systematically use the arm. If in any case after four weeks non-union exists, put up the arm in a plaster splint for three

or four weeks more. Some surgeons use a posterior right-angled trough instead of an an-

terior angular splint (Fig. 269).

Allis warmly advocates treatment in extension. He holds that the extended position secures the best circulation, and if either condyle is unbroken secures the benefit derivable from a natural splint. Furthermore, in fractures of the inner condyle, it restores the carrying function, which the flexed position does not do. For one week after the accident the patient stays in bed, with his arm extended upon a pillow. After swelling subsides the limb is wrapped firmly in a spiral flannel bandage and plaster is rubbed in or the bandage is covered with adhesive plaster.

Some surgeons extend the limb and apply an ordinary plaster bandage, and in about three weeks substitute an anterior angular splint. The trouble with treatment in extension is that if ankylosis ensues the limb is nearly useless. extension requires confinement to bed.



Fig. 277.—Frazier's modification of Jones's dressing for injuries of the elbow-joint.

Furthermore, treatment by

Jones, of Liverpool, thinks that splints and bandages are largely responsible for the stiffness which so commonly ensues upon an elbow injury. He advocates treatment by acute flexion in all elbow injuries except fracture of the olecranon. It has been demonstrated that the position of acute flexion forces the fragments into place and holds them firmly between the coronoid process of the ulna, the trochlear surface of the ulna, the fascia, and the triceps tendon. The surgeon must be certain that the radial pulse is perceptible after the elbow has been flexed. Flexion is maintained by fastening a bandage around the wrist and neck. The bandage around the neck passes through a rubber tube, which serves to protect the neck. The ball of the thumb should rest against the neck. The bandage is fastened to a leather band around the wrist. The most convenient dressing to maintain Jones's position was devised by Frazier; it is shown in Fig. 277.

After the dressing has been applied certain precautions are to be observed. For the first week or ten days look at the arm daily. If the swelling grows worse, diminish the degree of flexion, and do the same if there is severe pain.

If the radial pulse disappears, diminish the flexion until free circulation is obtained. This position is maintained from three to six weeks.\* Passive motion and massage are applied as if an anterior splint were being used. The author has treated a number of cases by Jones' method, and now prefers it to any other plan in all fractures of the elbow except fracture of the olecranon, transverse fracture above the condyles, fracture of the inner condyle near the line of the ulnar nerve, and fracture between the condyles in which the coronoid process gets between the fragments in flexion. The first-mentioned injury must be dressed in extension, the transverse fracture above the condyles requires an anterior angular splint, and the other two injuries should be treated in extension. If a fracture near the line of the ulnar nerve is treated in acute flexion, the callus poured out will be apt to entangle and press upon the nerve.

If it is found impossible to reduce the fragments or to maintain reduction we should follow the advice of John B. Roberts, make an incision and nail the

fragments in place. A comminuted fracture requires operation.

In young children the anterior angular splint must not be used. It will become loosened, and motion will inevitably take place at the seat of fracture. Such cases can be treated satisfactorily in Jones's position with Frazier's sling, or we can treat them in extension. Bertomier's plan is very useful in young children.† The extremity is dressed without pressure in extension and supination. This can be effected by flannel bandages. In from four to eight days a silicate of sodium bandage is applied in order to prevent pronation. About the sixteenth day the bandage is cut so as to form two troughs. From this period every third day the splints are removed and gentle passive motion is made. The splints are removed permanently at the end of four weeks.

If jalse ankylosis follows fracture of the elbow, the adhesions should be broken up under ether, and for some time the hot-air apparatus should be used daily and massage, passive motion, and the hot and cold douche should be employed. In true ankylosis an operation should be performed and the interlocking callus or the interposed tissue or fragment removed, if a skiagraph shows that operation promises success. If gunstock deformity results and produces marked disablement, it should be operated upon. An osteotomy is performed on the inner condyle. The arm is set in the extended position, plaster-of-Paris applied, and is not removed for six weeks.‡

Separation of the lower epiphysis of the humerus is a not unusual accident. The inferior extremity of the humerus may be separated, or the condyles may be separated from each other and from the shaft of the bone.

Symptoms.—The symptoms are prominence in front of the joint, caused by the lower end of the shaft of the humerus; projection backward of the olecranon; the forearm rests midway between pronation and supination. Epiphyseal separation may retard growth and produce deformity.

Treatment.—Jones's position or an anterior splint as above directed.

Fractures of the ulna comprise the following varieties: (1) fracture of the coronoid process; (2) fracture of the olecranon process; (3) fracture of the shaft; and (4) fracture of the styloid process.

Fractures of the coronoid process of the ulna are rarely observed, and practically occur only as a complication of backward dislocation of the ulna or in association with other fractures.

<sup>\*</sup> Provincial Medical Jour., Dec., 1894, and Jan., 1895.

<sup>†</sup> Révue de Chir., vol. viii, 1888.

<sup>‡</sup> G. G. Davis, Phila, Med. Jour., May 13, 1880.

Symptoms.—When fracture of the coronoid process is associated with a dis I cation, crepitus is appreciated on reduction, and it is found that the deformity of the dislocation promptly returns on cessation of extension. The upper fragment may be pulled upward by the brachialis anticus muscle, and there exists an inability to flex the forearm completely. The position is one of extension with posterior projection of the olecranon. The broken piece is felt in front of the joint.

Treatment.—The treatment is by an anterior splint the angle of which is less than a right angle. Jones's position may be used in treating such a

case. A stiff joint may follow.

Fractures of the olecranon process of the ulna occur not uncommonly in adults. Hulke states that such a fracture never occurs before the age of

fifteen, but the writer has seen in the Jefferson Medical College Hospital a girl aged fourteen with a fractured olecranon. The cause is direct violence or muscular action. Only a small fragment may be torn away, or the entire olecranon may be broken off, and the break may be comminuted or may even

be compound.

Symptoms.—The symptoms of fracture of the olecranon are: swelling; partial flexion of the forearm; separation of the fragments, the upper piece being pulled up from half an inch to two inches by the triceps; the space between the fragments is increased by nexion at the elbow, and lessened by extension at the elbow; and there is inability to extend the arm. Bulging of Treated by Jones's position. Degree of volunthe triceps above the fragments and crep- tary flexion obtained. itus on approximating the fragments



Fig. 278.-Fracture between the condyles.

are observed. In some few cases there is no separation, the periosteum being untorn or the fascial expansions from the triceps holding the fragments in apposition. In such cases crepitus can be elicited by rocking the upper fragment from side to side.

When treated by non-operative methods the prognosis is usually fair, fibrous union being the rule. Some joint-stiffness usually occurs, and much ankylosis may be unavoidable. The prospect of a freely movable joint is

better when extra-articular wiring is practised.

Treatment.-Fracture of the olecranon is usually treated with a wellpadded anterior splint almost, but not quite, straight. A perfectly straight splint is uncomfortable, and by opening a retiring angle between the fragments and into the joint favors non-union and ankylosis. The splint should reach from a level with the axillary margin to below the fingers. If the upper fragment does not come in contact with the lower, pull it down by adhesive plasler and fasten the strips to the splint. The author in one case employed a glove to which strings from the adhesive plaster were attached. After applying the splint keep the patient in bed for three weeks. The danger of ankylosis in this fracture is very great, and, in case it occurs in the position of extension, an almost useless arm results. Follow the rule of T. Pickering Pick, and at the end of three weeks anesthetize the patient, press the thumb firmly down upon the top of the olecranon, put the forearm at a right angle, and



Fig. 279. -Fracture between the condyles. Treated by Jones's position. Degree of voluntary extension obtained.

apply an anterior angular splint and direct it to be worn for two weeks. When the anterior splint has been applied, passive motion should be made every other day, or every third day, and massage should be used at the same time. When the splint is removed, try to increase the range of motion as previously directed. Surgeons usually incise and apply wires only when it is found



Fig. 280.-Fracture of coronoid process.

impossible to secure apposition of the fragments after fracture of the olecranon. Such a course is, I am persuaded, injudicious conservatism. I do not advise that the rule should be to treat fracture of the olecranon as a routine by opening and wiring, but I do advise that we should treat them by extraarticular operation and wiring as advocated by John B. Murphy ("Jour. Am. Med. Assoc.," Jan. 27, 1906). The conservative non-operative treatment often fails. Sometimes the fragments cannot be approximated, frequently they cannot be maintained in approximation, not unusually a stiff or actually inkylosed joint results. Murphy thus describes the operation which should be done ("Jour. Am. Med. Assoc.," Jan. 27, 1906). "A longitudinal incision of an inch long was made on the external aspect of the ulna, ½ of n inch from its articular surface, and tissues were divided to the bone.



Fig. 281 - Fracture of the shaft of the ulna (case in the Pennsylvania Hospital; skiagraphed by Dr. Gaston Torrance).

A smaller incision was made on the corresponding inner side. I perforated the base of the olecranon with an eyelet drill, which ran transversely from outward inward. I threaded the drill with a fine aluminum-bronze wire, drawing it through this transverse canal. The wire was carried upward under the skin on the inner surface of the elbow and then drawn out through another small incision,  $\frac{1}{16}$  of an inch, made at the level of the apex of the olecranon. The wire was then reinserted and directed transversely from inward outward, passing it through the tendon of the triceps above the olecranon, and then drawn out to corresponding outward point through

a very small incision similar to that made on the inner side. The wire was again reinserted and pushed downward under the skin until it was finally brought out through the initial external incision. The circle once completed, traction was exerted on the wire until I was sure that the two fragments were in perfect coaptation, the latter being easily and satisfactorily accomplished. The ends of the wire were twisted several times and then divided by scissors close to the bone. By this procedure the skin was incised at four points, the largest incision being \( \frac{1}{2} \) inch in length." The extremity is placed in flexion upon an anterior splint, which is worn for four weeks. Passive motion is begun on the third day. A compound fracture and a com-

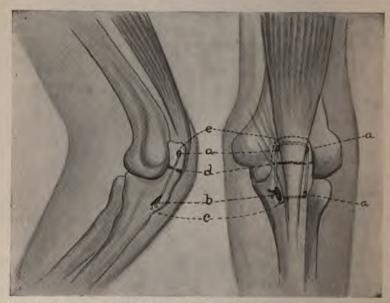


Fig. 282.—Murphy's method of treating fracture of the olecranon by subcutaneous exarticular wiring. Lateral view and posterior view. Wiring the fragments of the olecranon together: a, Incision; b, twist or tie of wire; c, hole drilled in bone for passage of wire; d, fracture; e, passage of wire through tendon of triceps (Murphy).

minuted fracture always require an operation, in which the joint is freely opened. Non-union requires opening of the joint and wiring of the fragments.

Fractures of the shaft of the ulna alone are most usual near the middle of the bone, are always due to direct violence, and are not infrequently compound. An injury which breaks the ulna is very apt to break the radius also.

Symptoms.—By running the finger along the inner surface of the bone there are detected inequality and depression; crepitus and mobility are easily developed; there are pain and the evidence of direct violence. The long axis of the hand is not on a line with the long axis of the forearm, but is internal to it. If deformity exists, it is due to the lower fragment passing into the interosseous space because of the action of the pronator quadratus; the upper fragment, acted on by the brachialis anticus, passes a little forward (Fig. 281). The

forearm at and below the seat of fracture is narrower and thicker than

Treatment.—In treating fracture of the shaft of the ulna place the forearm midway between pronation and supination, so as to bring the fragments together and to obtain the widest possible interosseous space, and thus limit the danger of union taking place between the radius and ulna. The position midway between pronation and supination is obtained by flexing the forearm to a right angle with the arm and pointing the thumb to the nose. Take two

well-padded straight splints, one long enough to reach from the inner condyle to below the fingers, the other from the outer condyle to below the wrist; place a long pad of lint over the interosseous space on the flexor side of the limb, and another on the extensor side; apply the splints and hang the



Fig. 283.—Two straight splints in fracture of both bones of the forearm.

forearm in a triangular sling (Fig. 283). Passive motion is to be made in the third week, and the splints are to be worn for four weeks. Fractures of the ulna can be treated very efficiently with plaster of Paris. The best results are secured by wiring.

Fractures of the styloid process of the ulna are due to direct force.

The displacement is obvious.

Treatment.—In treating fracture of the styloid process push the fragment back into place and use a Bond splint with a compress for four weeks, or apply a plaster-of-Paris dressing.

Fractures of the radius include the following varieties: (a) Fractures of its head; (b) fractures of its neck; (c) fractures of its shaft; and (d) fractures of its lower extremity.

Fracture of the head of the radius has been studied by Dr. T. Turner Thomas ("University of Penn. Med. Bulletin," Oct., 1905; and "Annals of Surgery." August, 1907). He has furnished me with the following resume of his views, with which I entirely agree:

"Fracture of the head of the radius is not infrequent and is usually the result of a fall on the hand, with the elbow in extension and the forearm in pronation. In extension of the elbow the capitellum of the humerus is in contact with only the anterior part of the radial head. Since the carpus articulates almost entirely with the radius, the force of the usual fall on the hand is transmitted almost entirely through this bone, and at the elbow is received by only the anterior part of the radial head. According to the degree of violence applied more or less damage may be done to the head, or head and neck. The anterior portion of the rim may be split off, the intact ulna preventing the humerus from pursuing the detached fragment and pushing it away from its fellow, and the intact orbicular ligament holding the two in close apposition. This uncomplicated fracture is the most common, but the least troublesome. Union with ultimately good function is the rule, even though the fracture go unrecognized and untreated, because of the close splinting of the

untorn orbicular ligament. Since it is the same accident, a fall on the outstretched hand, which usually produces Colles' fracture, fracture of the external condyle of the humerus, fracture of the neck of the radius, fracture of the coronoid process, and posterior dislocation of both bones of the forearm, any one or several of these injuries may complicate the fracture of the radial head. When the anterior part of the head breaks off the bony resistance to the descent of the capitellum by the radius is lost, so that if the force of the accident is severe enough, lateral bending of the elbow to the radial side with further descent of the capitellum may result with greater separation of the fragments, tearing of the orbicular ligament, and more damage to the head. The descent of the condyle in a posterior dislocation may carry before it the detached fragment of the head, and this fragment be left buried in the tissues of the forearm several inches below its normal position after the dislocation has been reduced.

"Prognosis.—In the vertical or oblique fissured fracture of the head with close approximation of the fragments, after union takes place, limitation of all movements of the elbow results from adhesions and slight irregularities in the bone. The function rapidly returns in the succeeding weeks, although some limitation of extension will continue for months. More marked irregularity in the circumference of the head may last much longer and may produce permanent limitation of rotation. Bony union between the head and corresponding surface of the ulna will prevent all rotation of the forearm. In either case flexion and extension usually return almost if not completely. Non-union of the fragments may induce pain and limitation of movement, especially rotation; but with close approximation of the fragments and an untorn orbicular ligament, an apparently perfect return of function may follow, the fragments moving smoothly as one piece within the ligament. The prognosis will depend chiefly upon the degree of damage done to the head and the separation of the fragments.

"Symptoms.—The most characteristic feature of this fracture is its obscurity. The thick muscular covering of the radial head, except posteriorly, the splinting effect of the orbicular ligament, and the close contact of the head with the humerus and ulna, make the diagnosis of the small intra-articular fracture particularly difficult. In the uncomplicated vertical fracture there will usually be no movements of the fragments on each other, and, therefore, no crepitus, and there will be no deformity. A history of a fall on the hand; some swelling of the elbow, particularly on the radial side; severe pain and limitation in all movements of the elbow, particularly in rotation; pain and tenderness distinctly localized to the head of the radius; and the exclusion of fracture of the humerus, ulna, and the shaft of the radius, will point strongly to a fracture of the head of the radius. If the injury is treated as a fracture, and two or three weeks later, when fixation is removed, there is marked limitation of all movements of the elbow, the diagnosis will be more than reasonably assured. The x-ray may be misleading unless directed in the line of the fracture, and this is not easy to accomplish, since the position of the fragments in their relation to the humerus vary with every change in rotation of the forearm. In most cases an exposure to the x-ray in the transverse plane of the humeral condyles, with the forearm in pronation, will give a successful skiagraph (see Fig. 285). If the

2-ray is directed at right angles to the line of fracture the skiagraph will usually be negative. If the fragments are freely separated and if crepitus is elicited,

the diagnosis will be more easily determined.

In the uncomplicated fracture without crepitus or deformity, Jones's position or a right-angled splint for three weeks will be sufficient. The resulting fibrous ankylosis will largely disappear from forced use in the following weeks, but several months will be necessary before extension is complete. If crepitus is present, four or five weeks' fixation will be better, and in this case the return of function will probably take longer. As a rule, if union is obtained function will return. If pain on movement persists for many months, a detached fragment or the whole head should be excised. Marked limitation of movement from enlargement of the head or bony union between it and the ulna calls for excision of the head."

Fracture of the neck of the radius is by no means as rare an accident as thought before the discovery of the x-rays. It seldom occurs alone and is



Fig. 284.—Impacted Colles' fracture.



Fig. 285,—Fracture of the neck of the radius.

usually associated with fracture of the radial head. These fractures are transverse and frequently impacted. The cause is a fall upon the pronated hand.

Symptoms.—In this fracture the forearm is pronated and the patient is found to have lost the power of voluntary pronation and supination. Under forced pronation and supination it will be noted that the head of the radius does not move unless there is impaction. Crepitus is sometimes absent because of impaction. Thomas points out that there is angulation of the neck due to

driving of the radial head downward and forward ("Annals of Surgery," August, 1907). Reduction is always difficult and may be impossible.

Treatment.—The treatment for fracture of the neck of the radius is the same as for fracture of the elbow-joint—namely, an anterior angular splint or Jones' position.

Fracture of the shaft of the radius is far commoner than fracture of the shaft of the ulna. It may occur above or below the insertion of the pronator



Figs. 286 and 287.—Fracture of both bones of the forearm.

radii teres muscle. It may arise from either direct or indirect force. Fracture of the shaft of the ulna may coexist as a result of the same accident.

Fracture of the Shaft of the Radius Above the Insertion of the Pronator Radii Teres Muscle.—Symptoms.—The upper fragment is drawn forward by the biceps and is fully supinated by the biceps and the supinator brevis. The lower fragment is fully pronated by the pronator quadratus and pronator radii teres, and its upper end is pulled into the interosseous space. There are crepitus, mobility, pain, narrowing and thickening of the forearm below the seat of fracture, and loss of the power of pronation and supination.

The head of the bone is motionless during passive pronation and supination.

The hand is prone,

Treatment.—In treating this fracture do not put the forearm midway between pronation and supination, as this position will not bring the fragments into contact, the upper fragment remaining flexed and supinated. To bring the lower fragment in contact with the upper, flex and fully supinate the forearm. Apply an anterior angular splint to the extremity for four weeks, and make passive motion in the third week.

Fracture of the Shaft of the Radius below the Insertion of the Pronator Radii Teres Muscle.—In this variety of fracture the upper fragment is acted on by the biceps, the supinator brevis, and the pronator radii teres, and it remains about midway between pronation and supination, passing forward and also into the interosseous space. The lower fragment is acted on by the supinator longus and the pronator quadratus, the latter being the more powerful of the two, hence the lower fragment is moderately pronated, its upper extremity being drawn into the interosseous space. Other symptoms are identical with those of fracture above the insertion of the pronator radii teres.

Treatment.—In treating fracture below the pronator radii teres the forearm is flexed and is placed midway between pronation and supination; two interosseous pads and two straight splints are applied as for fracture of the ulna Fig. 283). The splints are worn for four weeks, and passive motion is made in the third week. Plaster of Paris is a most satisfactory dressing. Loss of function is best obviated in this fracture by incision and fixation.

Fracture of the shafts of both bones of the forearm is not frequently seen. It is caused either by direct or indirect force.

Symptoms.—After fracture of both bones of the forearm the hand is pronated and the two lower fragments come together and are drawn upward and lackward or upward and forward by the combined force of flexor and extensor muscles, shortening being manifest and the projection of the lower fragments being detected on either the dorsal or the flexor surface of the forearm. The upper fragment of the ulna is somewhat flexed by the brachialis anticus; the upper fragment of the radius is flexed by the biceps and is pronated and drawn toward the ulna by the pronator radii teres. The forearm is narrower than it should be (the ends of the fragments having passed into the interosseous space) and is thicker than normal from front to back (the contents of the interosseous space having been forced out). Crepitus, mobility, pain, and inequality exist, the power of rotation is lost, and on passive rotation the head of the radius does not move. The forearm is prone and semiflexed.

Treatment.—The treatment usually consists in the application of two straight splints and two interosseous pads, the forearm being flexed to a right angle and placed midway between pronation and supination (Fig. 283). The splints are worn for four weeks, and passive motion is made in the third week. Instead of these splints a plaster-of-Paris dressing can be used. I am persuaded that pronation and supination are best preserved by incision and fination.

Fractures of the Lower Extremity of the Radius.—Colles' fracture is a transverse or nearly transverse fracture of the lower end of the radius, between

the limits of one-quarter of an inch and one and a half inches above the wristjoint, the lower fragment sometimes mounting upon the dorsum of the upper

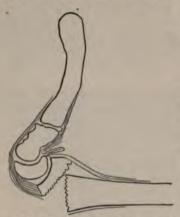


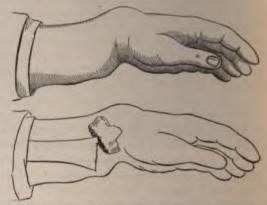
Fig. 288.—Effect upon the lower end of the radius of the cross-breaking strain produced by extreme backward flexion of the hand (Pilcher).

fragment. An oblique fracture beginning within half an inch of the joint and passing into the joint is known as Barton's fracture. Colles's fracture was first recognized as a fracture by Colles, of Dublin, in 1814. Before his time the injury was called backward dislocation of the wrist. It is a very common injury, is met with most frequently in those beyond the age of forty, and oftener in women than in men. It is due to transmitted force (a fall upon the palm of the pronated hand). Some think that the force is received by the ball of the thumb and passes to the carpal bones and the edge of the radius; a fracture beginning posteriorly rather than anteriorly and the force driving the lower fragment upon the dorsal surface of the radius, the carpus and lower fragment moving upward and outward.

It is much more likely that this fracture is due to cross-strain on the bone. There is sudden traction upon the anterior ligaments, which drag upon the bone and break it at a point where the cancellous end of the radius joins

the compact shaft (Fig. 288). The fragments are not unusually impacted. In the author's experience dislocation of the lower end of the ulna is a not unusual complication, which arises from a fracture of the ulnar styloid or tearing off of the internal lateral ligament of the wrist.

Symptoms.—In Colles's fracture the hand is abducted (drawn to the radial side of the forearm) and pronated, the head of the ulna is prominent, the styloid process of the radius is



Figs. 289, 290.—Deformity at the wrist consequent upon displacement backward of the lower fragment of the radius after fracture at its lower extremity (Levis).

raised, and the lower fragment may mount on the back of the lower end of the upper fragment, causing a dorsal projection, termed by Liston the "silver-fork deformity" (Figs. 289 and 290). The lower end of the upper fragment can be felt beneath the flexor tendons above the wrist. The position in deformity is produced by the force. Some consider it is maintained by the action of the supinator longus and the flexor and extensor muscles, but particularly by the extensors of the thumb. Pilcher

has demonstrated the fact that in this fracture a portion of the dorsal periosteum is untorn, and this untorn portion acts as a binding band to hold the fragments in deformity. Pronation and supination are lost. In this fracture the hand can be greatly hyperextended (Maisonneuve's symptom). Crepitus, which is best obtained by alternate hyperextension and flexion, can be secured unless swelling is great or impaction exists. Crepitus on side movements is marely obtainable. Impaction may greatly modify the deformity, though displacement generally exists to some extent, and the fragments do not ride easily on each other. The styloid process of the ulna may be broken, or the inferior radio-ulnar articulation may be separated. This latter complication allows the lower fragment to roll freely upon the upper, and the characteristic silver-fork deformity does not appear. If the styloid process of the ulna is



Fig. 291.—Colles's fracture of the radius (Pennsylvania Hospital case; skiagraphed by Dr. Gaston Torrance).

broken, pressure over it causes great pain. If a person in falling strikes the back of the hand and a fracture of the radius occurs, the lower fragment is driven upon the front surface of the upper fragment and is felt under the flexor tendons at the wrist. An elaborate study of fracture of the radius with forward displacement of the lower fragment has been published by John B. Roberts.\*

Treatment.—In treating Colles's fracture reduce the deformity by hyperextension to unlock the fragments and relax the dorsal periosteum, and follow by longitudinal traction to separate the fragments, and forced flexion to force them into position. This formula was introduced many years ago by the late R. J. Levis. It is of the first importance to thoroughly reduce this fracture, and very often it is not thoroughly reduced. Imperfect reduction means permanent deformity, stiffness of the tendons and wrist, and possibly an almost useless hand. The extremity can be placed upon a Levis splint (Fig. 292), the position maintaining reduction and the tense extensor tendons giving dorsal support. Some surgeons use Gordon's pistol-shaped splint. The favorits splint in

<sup>\*</sup> Am. Jour. Med. Sci., Jan., 1897.

Philadelphia practice in the past has been Bond's (Pl. 6, Fig. 7). It places the hand in a natural position of rest (semiflexion of the fingers, semi-extension of the wrist, and deviation of the hand toward the ulna). Two pads are used: a dorsal pad which overlies the lower fragment, and a pad for the flexor surface

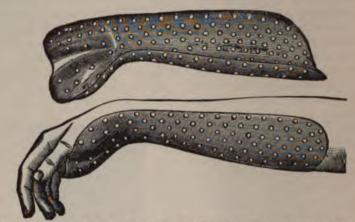


Fig. 202 .- Levis's radius-splints, right and left, for fracture of the lower end of the radius.

which overlies the lower end of the upper fragment. A bandage is applied, the thurab and fingers being left free (Fig. 293). Passive motion is begun upon the fingers in three or four days, and upon the wrist during the second week. The splint is removed in three weeks, and a bandage is worn for a week or two more because of the swelling. In applying the Bond splint, do not pull the hand too much up on the block, or the fracture will unite with a projection upon the flexor surface of the extremity and the tendons of the wrist will be apt to be caught in the callus. The most satisfactory dressing is the straight dorsal splint advised by Roberts (Fig. 294). I use it almost invariably. It prevents the recurrence of deformity and is mechanically



Fig. 293.—Bond's splint in Colles' fracture.

the proper mode of treatment. It should be worn for three weeks. Undoubtedly more or less stiffness often follows Colles's fracture, and some very able surgeons have been so impressed with the frequency of its occurrence that they have dispensed with the use of a splint. Sir Astley Cooper long ago spoke of placing the arm in a sling as proper treatment for fracture of the radius. Moore, of Rochester, applied a cylindrical compress over the ulna, held in place for six hours with adhesive plaster, then cut the plaster, placed the forearm in a sling, and let the hand hang over the edge of the sling. Pilcher applies a band of adhesive plaster around the

wrist and supports the wrist in a sling, but, as Storp says, dispensary patients are apt to disarrange this dressing. Storp wraps a piece of rubber plaster four inches wide around the wrist, and places a second piece around the first so arranged as to form a fold over the radius; an opening is made through the fold for the passage of a sling. In ten days the plaster is removed and the forearm is carried in a sling. If a stiff joint and limited tendon-motion eventuate from the fracture, use massage, frictions, sorbefacient ointments, tincture of iodin, electricity, hot and cold douches, and the hot-air apparatus, or give ether and forcibly break up adhesions. If reduction was not thoroughly effected and too great a length of time has not elapsed, and the hand is helpless and painful, the bone should be refractured. In a young or middle-aged person, in whom a useless hand has followed an ill-reduced fracture, osteotomy is justifiable.

Fracture of both the Radius and Ulna near the Wrist.—Colles's fracture may be complicated by a fracture of the ulna other than of its styloid process,

Symptoms.—In fracture of the radius and ulna near the wrist the lower ends of the upper fragments come together, the upper fragment of the radius is pro-

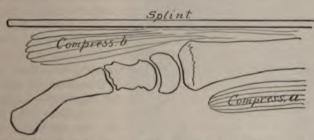


Fig. 294.—Diagram showing the arrangement of compresses and splint best adapted to retain fragments in proper position after reduction (Pilcher).

nated, and the lower fragment of the radius is drawn up. Pain, crepitus, mobility, shortening, and loss of function exist.

Treatment.—Fracture of the radius and ulna near the wrist should be treated with the straight dorsal splint, as in Colles's fracture.

Separation of the Lower Radial Epiphysis.—This accident occurs in children from falling upon the palm of the hand. It never happens after the twe ntieth year.

Symptoms.—In separation of the lower radial epiphysis the lower fragment into upon the upper and produces a dorsal projection like Colles's fracture, the hand does not deviate to the radial side. The deformity resembles that backward carpal dislocation, but is differentiated from dislocation by the level relation in the fracture between the styloid processes and the carpal

the Same as for Colles's fracture.

the arrays have taught us differently, and we now know that many supposed sprains of the wrist are in reality simple fractures of the carpus. Codman

and Chase show that a majority of carpal injuries "are either simple fractures of the scaphoid or anterior dislocations of the semilunar bone," the two injuries being frequently combined ("The Diagnosis and Treatment of Fracture of the Carpal Scaphoid and Dislocation of the Semilunar Bone," Ernest Amory Codman and Henry Melville Chase, in "Annals of Surgery," March and June, 1905). The cause of carpal fractures may be violent direct force or falls upon the extended palm.

Symptoms.—Fractures of the carpus in general are indicated by pain, swelling, evidences of direct force, sometimes crepitus, loss of power in the

hand, and a very little displacement.

Treatment.—Many compound comminuted fractures of the carpus require amputation. In an ordinary compound fracture asepticize, drain, dress with antiseptic gauze and a plaster-of-Paris bandage, cutting trap-doors in the plaster over the ends of the drainage-tube. In a simple fracture dress the hand upon a well-padded straight palmar splint (Pl. 6, Fig. 10) reaching from beyond the fingers to the middle of the forearm, and place the hand and forearm in a sling. The splint is worn for four weeks, and passive motion of the wrist is begun in the second week.

Fracture of the carpal scaphoid (see previously quoted article by Codman and Chase) usually results from falls upon the palm of the extended hand and is most common in males between the ages of twenty-five and thirty-five. It is rarely recognized at the time of the accident; the patient complains of severe pain, tenderness, and disability and is thought to have a sprain. According to Codman and Chase, the symptoms improve up to a certain point but not beyond it and the joint remains in a condition of irritation and weakness. After months or, perhaps, years, the diagnosis is made. In one case of my own, a locomotive engineer, the injury resulted from a blow on the palm with the reverse lever. He came to me three years after the injury when I recognized the condition as the one described by Codman and Chase. These writers say that the fingers are normally flexible, active and passive movements of the wrist are restricted to one-half or more of the normal excursion, and movements of flexion or extension beyond this are limited by muscular spasm, resembling the spasm occurring in a tuberculous joint. Any attempt to forcibly overcome the spasm produces violent pain. Crepitus is absent. The radial side of the wrist-joint exhibits some swelling, which obscures somewhat the flexor tendons of the thumb. There is tenderness on pressure over the scaphoid and it is most acute in the anatomical snuff box. The x-ray shows a transverse fracture of the scaphoid bone ("Annals of Surgery," March and June, 1905). Professor Dwight considers the above-described injury to be due to the two portions of the bone (there are two centers of ossification) having never formed a bony union and having been wrenched apart by violence. Codman believes the injury is the result of violence acting on a normal bone, the resulting non-union being due to lack of fixation and the presence of synovial fluid between the fragments.

The fracture may be accompanied by forward dislocation of the semilunar bone. If for several weeks after an accident causing fracture of the scaphoid the wrist is immobilized, union may occur, otherwise non-union will surely result.

Treatment.—This injury should be thought of when violence has been

applied to the carpus. It may be treated by a straight palmar splint if the case is seen early. If seen when there is non-union, the proximal half of the scaphoid should be excised (the incision being posterior and external to the extensor communis digitorum tendons) and passive motion should be begun within one week (Codman and Chase, in "Annals of Surgery," March and June, 1905).

Fractures of the Metacarpal Bones.—Fracture of the metacarpus is very common. One or more bones may be broken. The first metacarpal bone is oftenest broken; the third is seldom broken (Hulke). The cause is direct or indirect force. Fracture at the base of the first metacarpal bone was described by E. H. Bennett in 1881. It is called Bennett's fracture, or,

as its discoverer named it, "slave of the thumb." fracture may be transverse at the neck or longitudinal, "the anterior basal projection being broken off" (Raymond Russ, in "Jour. Am. Med. Assoc.," June 16, 1906). This injury results from violent force applied to the distal end of the metacarpal (as in striking with the fist) or to the end of the extended thumb, and Russ regards it as the most common metacarpal fracture. It is usually mistaken for a sprain of the thumb and is sometimes regarded as subluxation backward of the first metacarpal.

Symptoms.—The signs of a metacarpal fracture are—dorsal projection of the upper end of the lower fragment or the lower end of the upper fragment; pain; crepitus; and often evidences of direct vio-



Fig. 295.-Coaptation-traction splint of Russ.

lence. In fracture of the first metacarpal (Bennett's fracture) there is swelling, particularly evident in the flexor tendon sheaths on the thenar eminence (Russ), disability, pain, tenderness near the base of the metacarpal, and deformity, apparent shortening of thumb, and crepitus on reduction. The x-ray solves a doubtful case.

Treatment.—To treat a fracture of a metacarpal bone reduce by extension; place a large ball of oakum, cotton, or lint in the palm to maintain the natural rotundity, and apply a straight palmar splint like that used for fracture of the carpus. It may be necessary to apply a compress over the dorsal projection. The duration of treatment is three weeks, and passive motion is begun after two weeks. A plaster-of-Paris dressing is often used.

Raymond Russ ("Jour. Am. Med. Assoc.," June 16, 1906) describes the following splint as successfully used in a case of Bennett's fracture. I have used it in a case with much satisfaction. "The thumb was put in strong abduction and three wooden skewers—butcher's—neatly padded were placed about the metacarpal, one posteriorly in the interosseous space, one along the outer border, and the third over the thenar eminence. These extended from well above the metacarpal bone to the first phalangeal joint. They were fastened tightly in place by two strips of adhesive plaster. Traction was then exerted on the thumb and maintained by strips of adhesive plaster passing about the first phalanx and the projecting ends of the three skewers. This dressing was reinforced by a rectangular cardboard splint. Accurate coaptation and sufficient traction to overcome the deformity and muscular action are most necessary in the treatment of this fracture. Slate pencils or small lead pencils can be used in place of the wooden skewers. The soapstone slate pencils are less brittle than the ordinary kind."

Fractures of the Phalanges.—The phalanges are often broken. The fracture may be compound. The cause usually is direct force.

Symptoms.—Fracture of a phalangeal bone is indicated by pain, bruising,

crepitus, and mobility, with very little or no displacement.

Treatment.—If the middle or distal phalanx is broken, mould on a troughlike splint of gutta-percha or of pasteboard, which splint need not reach into the palm. If the proximal phalanx is broken, carry the splint into the palm of the hand. Make the splint of gutta-percha, pasteboard, wood, or leather. The splint is worn three weeks. A sling must be worn, otherwise the finger will constantly be knocked and hurt. Some cases require a dorsal as well as a palmar splint. These cases are dressed most satisfactorily with a silicate of sodium or plaster-of-Paris bandage.

Fracture of the femur is a very common injury. The divisions of the femur are (1) the upper extremity; (2) the shaft; and (3) the lower extremity.

1. Fractures of the upper extremity of the femur are divided into:
(a) intracapsular; (b) extracapsular; (c) of the great trochanter; and (d) epiphyseal separation (either of the great trochanter or the head).

Examination of the Hip.—It is sometimes though seldom necessary to give ether. Remove all the patient's clothing and place him recumbent upon a table. Note the position of the extremity. Feel with care the great trochanter and femoral neck. Very gradually and gently make movements to determine if there is impairment, undue mobility, or crepitus. Never make sudden or violent movements in looking for crepitus. The diagnosis can be made even if crepitus is not obtained, and rapid or violent movements may tear apart an impaction. Measure the sound extremity and the injured extremity. The measurement is made from the anterior superior spine of the ilium to the inner malleolus. Other symptoms to be looked for are set forth on pages 500 and 501.

Intracapsular Fracture of the Femur.—Intracapsular fracture of the neck of the femur is transverse or only slightly oblique (Fig. 296), and is not unusually impacted (Figs. 239, 240, 243). Stokes follows Gordon, of Belfast, in classifying fractures of the femoral neck. He divides them into intracapsular and extracapsular, and subdivides intracapsular fractures into fracture with penetration of the cervix into the head; fracture with reciprocal penetration;

intraperiosteal fracture at the junction of the cervix and head; intraperiosteal fracture of the center of the cervix; extraperiosteal fracture, with laceration of the cervical ligaments. The last-named fracture is the most common. The first four forms may unite by bone, the fifth form will not because of non-apposition, lack of nutrition, effusion of blood, synovitis, or interstitial absorption.\* Stokes claims that we may have penetration, but not impaction. The cause is often slight indirect force, of the nature of a twist, acting upon a person of advanced years (more often a woman than a man), but not unusually a fall upon the great trochanter is the cause. A fall upon the knees,



Fig. 196.—Imracapsular fracture of the hip (Pennsylvania Hospital case; skiagraphed by Dr. Gaston Torrance).

a trip, or an attempt to prevent a fall may produce this fracture. It often happens that the fall is due to the fracture rather than that the fracture arises from the fall. Intracapsular fracture is never caused by direct force unless it is due to gunshot violence. The aged are more liable to intracapsular fracture than the young or the middle-aged, because, first, the angle which the neck forms with the axis of the femur becomes less obtuse with advancing years, and may even become a right angle; this change is more pronounced in women than in men; secondly, the compact tissue becomes thinned by absorption, the cancelli diminish, the spaces between them enlarge, the bony portions of the cancellous structure are thinned and destroyed,

<sup>\*</sup>Stokes, in Brit. Med. Jour., Oct. 12, 1895.

and the cancellous structure becomes fatty and degenerated. The injury is not, however, limited to the aged. It has been positively shown that this fracture may occur in the young, even before the union of the epiphyses. In fact, fracture of the femoral neck is not very uncommon in children and in young and vigorous adults (Royal Whitman, "Med. Record," March 19, 1904). I have seen one case in a man of twenty-eight and several cases in those under forty-five. In the aged the fracture is, of course, complete, but in children and even in young adults it is usually incomplete, and for this reason the fracture is often not recognized in children and young adults.

Symptoms.—In intracapsular fracture there is usually shortening to the extent of from half an inch to an inch; but in some cases no shortening can be detected. Shortening of a quarter of an inch does not count in making a diagnosis, for one limb is often naturally a little shorter than the other. If the reflected portion of the capsule is not torn, the shortening is trivial in amount or is entirely absent. In some cases shortening gradually or suddenly increases some little time after the accident. This is due to separation of a penetration, tearing of the previously unlacerated fibrous synovial reflection, or restoration of muscular strength after traumatic paresis has passed away. A gradually increasing shortening arises from absorption of the head of the bone. Shortening is due chiefly to pulling upon the lower fragment by the hamstring, the glutei, and the rectus muscles.

Pain is usually present anteriorly, posteriorly, and to the side. The area of pain is localized, and motion or pressure greatly increases the suffering. Pain is not commonly severe except upon motion, when it may be localized in

the joint. In some cases the pain is violent.

Eversion exists and is spoken of as "helpless eversion," though in a very few instances the patient can still invert the leg. This eversion is due to the force of gravity, the limb rolling outward because the line of gravity has moved externally. That eversion is not due to the action of the external rotator muscles, as was taught by Astley Cooper, is proved by the fact that when a fracture happens in the shaft below the insertion of these muscles the lower fragment still rotates outward. This is further demonstrated by the considerations that the internal rotators are more powerful than the external, that some patients can still invert the limb after a fracture, and that eversion persists during anesthesia.\* In some unusual cases inversion attends the fracture. Inversion, if it exists, is due to the fact that the limb was adducted and inverted at the time of the accident, and after the accident it remains in this position (Stokes). Besides shortening and eversion, the leg is somewhat flexed on the thigh and the thigh on the pelvis, the extremity when rolled out resting upon its outer surface. Abduction is commonly present.

Loss of power is a prominent symptom: the limb can rarely be raised or inverted; although in rare cases, when the fibrous synovial envelope is untorn, the patient may stand or even take steps. Crepitus often cannot be found, either because the fragments cannot be approximated, because penetration exists, or because the bone is greatly softened by fatty change. To obtain crepitus the front of the joint must be examined while the limb is extended and rotated inward. But why try to obtain crepitus? The diagnosis is readily

<sup>\*</sup>Edmund Owen: "A Manual of Anatomy."

made without it; in many cases it cannot be detected, and the endeavor to obtain it inflicts pain and may produce damage. These fractures in the aged offer a not very flattering chance of repair, and efforts to find crepitus may produce serious damage. Limited abduction suggests impaction.

Altered Arc of Rotation of the Great Trochanter (Desault's Sign).-The pivot on which the great trochanter revolves is no longer the acetabulum, and the great trochanter no longer describes the segment of a circle, but rotates only as the apex of the femur, which rotates around its own axis. It is needless to try to obtain this sign; to do so inflicts violence on the parts.

Relaxation of the fascia lata (Allis's sign) simply means shortening. The fascia lata is attached to the ilium and the tibia (ilio-tibial band), and when shortening brings the tibia nearer to the ilium, this band relaxes and permits the surgeon to push his fingers more deeply inward on the injured side, between the great trochanter and the iliac crest, and near the knee above the outer condyle, than on the sound side. In this examination each limb should be adducted. Allis has pointed out another sign: when the patient is recumbent the sound thigh cannot be lifted to the perpendicular without flexing the leg; the injured thigh can be.

Lagoria's sign is relaxation of the extensor muscles.

Ascent of the Great Trochanter above Nelaton's Line .- This line is taken

from the anterior superior iliac spine to the most prominent part of the ischial tuberosity (Fig. 297). In health the great trochanter is below, and in

intracapsular fracture it is above, this line.

Relation of the Trochanter to Bryant's Triangle (Fig. 207).-Place the patient recumbent, carry a line around the body on a level with the anterior superior iliac spines, draw a line from the anterior iliac spine on each side to the summit of the corresponding great trochanter, and measure the base of the triangle from the great trochanter to the



Fig. 297.-A C D, Bryant's ilio-femoral triangle; A B, Nélaton's line (Owen).

perpendicular line to determine the amount of ascent. The difference in measurement between the two sides shows the amount of ascent of the trochanter; that is, shows the extent of shortening.

Morris's measurement shows the extent of inward displacement. Measure from the median line of the body to a perpendicular line drawn through

the trochanter on each side of the body.

Diagnosis.—The x-rays are a valuable aid to diagnosis (Fig. 206). Intracapsular fracture without separation of fragments may be mistaken for a mere contusion, and the diagnosis may continue obscure unless the fragments separate. Loss of function in contusion is rarely complete or prolonged, although occasionally the head of the bone is absorbed. Early after a contusion, and usually throughout the case, there is no alteration between the relation of the spine of the ilium and the trochanter, and no shortening. Some little time after a severe contusion the head of the bone may be absorbed. Contusion of a rheumatic joint leads to much difficulty in diagnosis. Intracapsular fracture may be confused with extracapsular fracture or with a dislocation of the hip-joint. Extracapsular fracture, which is common in advanced life, but is met with in middle life or even occasionally in the young, results usually from great violence over the great trochanter; if non-impacted, there are noted shortening of from one and a half to three inches, crepitus over the great trochanter, and usually, but not invariably, eversion; if impacted, there is less eversion, crepitus is almost or entirely absent, and the shortening is limited to about an inch. The extensor muscles are relaxed. Great tenderness exists over the great trochanter in both impacted and non-impacted fractures. In dislocation on the dorsum of the ilium the patient is usually a strong young adult. There is a history of forcible internal rotation. There are inversion (the ball of the great toe resting on the instep of the sound foot), rigidity, ascent of the great trochanter above Nélaton's line, and shortening of from one



Fig. 298.—Recent intracapsular fracture in a woman aged forty successfully nailed.

to three inches. The head of the bone is felt on the dorsum of the ilium, and the trochanter mounts up toward the spine of the ilium, and pressure upon it causes no pain. In dislocation into the thyroid notch there is possibly eversion, but it is linked with lengthening.

In *fracture of the brim of the acetabulum* there is shortening, which occurs on the removal of extension, inversion, abduction, flexion of the knee, the head of bone is drawn upward and backward with the acetabular fragment, and there is retention of the power of eversion and of adduction (Stokes). Crepitus is most distinctly appreciated by a hand resting on the ilium. In

fracture of the fundus of the acetabulum there is shortening, and the head of the bone enters the pelvis (Stokes).

Prognosis.—The prognosis is not very favorable. Some aged patients die in a day or two from shock. Not a few perish later from hypostatic congestion of the lungs, kidney failure, or exhaustion. The majority of cases recover with a little shortening, some stiffness, and a permanent limp. There is a much better chance for firm union if the fracture is impacted than if it is not. Even if non-union results after an intracapsular fracture, and it is not unusual, a patient may get about fairly well with a proper support. In some cases after intracapsular fracture rheumatoid arthritis develops. Many surgeons have maintained that bony union never occurs, but it certainly does sometimes take place. Stokes holds that bony union is possible in fractures with penetration, and even in fractures without penetration when the fracture is within the periosteum.\*

Treatment.-In treating a very feeble old person for intracapsular fracture make no attempt to obtain union. Keep the patient in bed for two weeks; give lateral support by sand-bags; tie around the ankle a fillet, attach a weight of a few pounds to the fillet, and hang the weight over the foot-board of the bed. When pain and tenderness abate, order the patient to get into a reclining-chair, and permit him very soon to get about on crutches. If hypostatic congestion of the lungs sets in, if bed-sores appear, if the appetite and digestion utterly fail, or if diarrhea persists, abandon attempts at cure in any case, and get the patient up and take him into the sunshine and fresh air, simply immobilizing the fracture as thoroughly as possible by means of pasteboard splints or plaster-of-Paris. In the vast majority of cases, no matter how old the patient may be, undertake treatment. We may be forced to abandon it, but should at least attempt to obtain a cure. If it is determined to treat the case, place the patient on a hair mattress, several boards being laid under the mattress transversely in order to prevent unevenness and the formation of hollows. A fracture-bed is a valuable adjunct to treatment.

Treatment by the extension apparatus of Gurdon Buck: Extend the knee, and place the leg in a natural posture, and put a pillow beneath the knee. Combine extension with lateral support by means of sand-bags. The extension should be gentle, never forcible. It is not wise to pull apart a penetration in an old person, but it should always be done in a young or middle-aged person. Place the subject on a firm mattress. If the patient be a man, shave the leg. Cut a foot-piece out of a cigar-box, perforate it to admit the passage of a cord, wrap it with adhesive plaster as shown in Plate 6, Figs. 15 and 16, run the weight-cord through the opening in the wood, and fasten a piece of adhesive plaster on each side of the leg, from just below the seat of fracture to above the malleolus (Pl. 6, Fig. 14). The plaster is guarded from sticking to the malleoli by having another piece stuck to its under surface opposite each of these points. Apply an ascending spiral reversed bandage over the plaster to the groin (Fig. 299), and finish the bandage by a spica of the groin, Slightly abduct the extremity. Put a brick under each leg of the bed at its foot, thus obtaining counter-extension by the weight of the body, Run a cord over a pulley at the foot of the bed, and obtain extension by the

<sup>\*</sup> See the masterly paper by Stokes, before quoted.

use of weights. In an adult from fifteen to twenty pounds will probably be necessary at first, but after a few days from eight to ten pounds will be found sufficient (remember that a brick weighs about five pounds). Dawbarn's rule as to the proper weight to be attached is one pound for every year up to twenty. When the foot of the bed is raised and the weight to make extension is applied, very gently rotate the extremity, put the foot at a right angle with the leg, and make a bird's-nest pad of cotton or oakum to save the heel from pressure. Take two canvas bags, one long enough to reach from the crest of the ilium to the outer malleolus, the other long enough to reach from the perineum to the inner malleolus. Fill the bags three-quarters full of dry sand, sew up their ends, cover the bags with slips, and put the bags in place in order to correct eversion. The slips may be changed every third or fourth day. Keep the bed-clothing from coming in

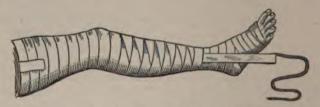


Fig. 299.—Adhesive plaster applied to make extension.

contact with the foot by means of a cradle (Figs. 300, 301). The bowels are to be emptied and the urine is to be voided in a bed-pan, unless using a fracture-bed. For two weeks the patient remains recumbent, after which time he can be propped up on pillows. Maintain extension for three weeks, then simply maintain support by sand-bags or molded pasteboard splints upon the part, and keep up this support three to five weeks more. After removing the extension he can be transferred daily to a couch. In from six to eight weeks after the infliction of the injury he can be moved about in a wheelingchair, the leg being extended or the knee flexed in accordance with the dictates of comfort. After a week or so of such movement a thick-soled shoe is placed on the sound foot and the patient is allowed to use crutches; but weight is not put upon the injured extremity until from ten to twelve weeks have elapsed from the time of the accident. For many months, at least, and possibly permanently, he walks with the aid of a cane. Union, if it takes place, is usually cartilaginous, but is sometimes bony, and there will surely be some shortening and also some stiffness of the joint. Passive motion is not made until at least eight weeks have elapsed since the accident. Treatment by the extension apparatus is far from satisfactory, as it does not afford sufficient immobilization.

Senn's method: Senn claims that by this method of "immediate reduction and permanent fixation" bony union is obtained in fractures of the neck of the femur within the capsule. He "places the patient in the erect position, causing him to stand with his sound leg upon a stool or box about two feet in height; in this position he is supported by a person on each side until the dressing has been applied and the plaster has set.

"Another person takes care of the fractured limb, which in impacted fractures is gently supported and immovably held until permanent fixation has been secured by the dressing. In non-impacted fractures the weight of the fractured limb makes auto-extension, which is often quite sufficient to

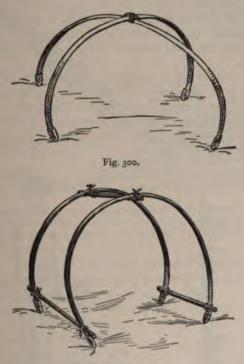


Fig. 301.

Figs. 300, 301.-Cradle to keep clothing from leg, made from two barrel-hoops (Scudder).

restore the normal length of the limb; if this is not the case, the person who has charge of the limb makes traction until all shortening has been overcome as iar as possible, at the same time holding the limb in position, so that the great toe is on a straight line with the inner margin of the patella and the american superior spinous process of the ilium. In applying the plaster-of-Paris bandages over the seat of fracture a fenestrum, corresponding in size to the dimensions of the compress with which the lateral pressure is to be made, is left open over the great trochanter.

"To secure perfect immobility at the seat of fractures, it is not only necessary to include in the dressing the fractured limb and the entire pelvis, but it is absolutely necessary to also include the opposite limb as far as the knee and to extend the dressing as far as the cartilage of the eighth rib.

"The splint (Fig. 302) is incorporated in the plaster-of-Paris dressing, and it must carefully be applied, so that the compress, composed of a well-

cushioned pad with a stiff, unyielding back, rests directly upon the trochanter major, and the pressure, which is made by a set-screw, is directed in the axis of the femoral neck. Lateral pressure is not applied until the plaster has completely set. Syncope should be guarded against by the administration of stimulants.

"As soon as the plaster has sufficiently hardened to retain the limb in proper position the patient should be laid upon a smooth, even mattress, without pillows under the head, and in non-impacted fractures the foot is held in a straight position and extension is kept up until lateral pressure can

be applied.

"No matter how snugly a plaster-of-Paris dressing is applied, as the result of shrinkage it becomes loose, and without some means of making lateral pressure it would become necessary to change it from time to time in order to render it efficient. But by incorporating a splint in the plaster dressing (Fig. 303) this is obviated, and the lateral pressure is regulated,

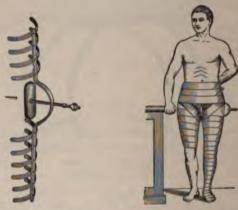


Fig. 302.—Senn's apparatus. Fig. 303.—Senn's apparatus applied.

day by day, by moving the screw, the proximal end of which rests on an oval depression in the center of the pad."

Treatment by Thomas's splint: Scudder, in his valuable treatise on "The Treatment of Fractures," advocates in intracapsular fracture the use of Thomas's hip splint. If the bones are unimpacted, the fragments are brought into apposition by extension, inversion, and pressure upon the great trochanter, and the Thomas splint is bent to fit, is padded, and is applied (Figs. 306, 307). When the bed-pan is to be used or the bed is to be smoothed, the patient can be lifted without disturbing the fracture. He can be turned on the sound side. If hypostatic congestion is developing, raise the head of the bed and tie the splint to the iron of the head of the bed. In addition to the use of the splint Scudder advocates the making of lateral pressure over the great trochanter by a graduated compress and a bandage. The splint is

worn for six or eight weeks. It is then removed, the patient remaining in bed four weeks longer without any apparatus (Scudder, from Ridlon).



Fig. 304.—The long spica as applied for fracture of the neck of the femur in the adult; illustrating the advantage of an appliance which permits movement without danger of displacing the fragments; an opening has been made to lessen the constriction of the abdomen (Whitman).

Whitman's Treatment in Abduction: The plan advocated by Royal Whitman ("Med. Record," March 19, 1904) is a most excellent one. It aims to abolish traumatic depression of the neck of the femur.

We can apply this plan in a young person to any fracture even if im-

pacted. In an aged person we apply it only in a complete non-impacted fracture. In a young person we give ether and pull apart an impaction by abduction. In an aged person we should not do so.

The extremity is set in extension and extreme abduction and plaster-of-Paris is applied. The tension of the capsule pushes the outer fragment against the inner and holds it; fixation is obtained by the neck of the femur being in contact with the acetabulum and the great trochanter with the pelvis, deformity cannot be caused by muscular action, and the psoas helps pull the fragments together (Whitman).

Extracapsular Fracture (Fracture of the Base of the Neck of the Femur).

The line of extracapsular fracture is

a.

Fig. 305.—Reduction and fixation in abduction, showing security assured by direct bony contact of the neck and trochanter with the pelvis, also the effect of the attitude on muscular action (Whitman). a, Abductor group; b, ilio-psoas; c, capsule.

at the junction of the neck with the great trochanter, and is partly within and partly without the capsule, the fracture being generally comminuted and often

impacted. The cause is violent direct force over the great trochanter (as by falling upon the side of the hip). This fracture is most usual in elderly people, but is not very uncommon in young adults. Stokes has described six forms of extracapsular fracture: extracapsular fracture with partial impaction posterior; fracture with complete impaction; fracture with partial impaction above; fracture with partial impaction below, the shaft being split; splitting the neck longitudinally without impaction; comminuted non-impacted fracture.\*

Symptoms.—When impaction is absent there is marked crepitus on motion, which is manifested most distinctly when the fingers are placed upon the great trochanter; there is severe pain, pressure upon the great trochanter is very painful, swelling and ecchymosis are marked; there is absolute inability on the part of the patient to move the limb, and passive movements cause violent pain; there is shortening to the extent of at least

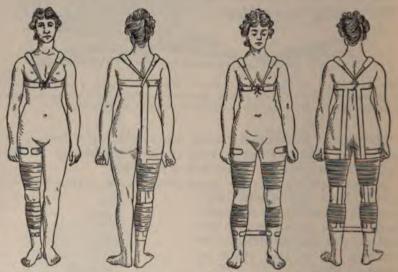


Fig. 306.—Thomas's single hip-splint in position (Ridlon).

Fig. 307.—Thomas's double hip-splint in position (Ridlon).

one and a half inches, and sometimes to the extent of three inches, which shortening is made manifest by noting the ascent of the trochanter above Nélaton's line, by a comparison of measurements of the injured limb and the sound limb, and by measuring the base-line of Bryant's triangle on each side. Absolute eversion usually exists with slight flexion both of the leg and the thigh. In some rare cases there is inversion. This happens if at the time of the accident the limb was inverted and adducted (Stokes). Lagoria's sign, Desault's sign, and Allis's signs are present. All these symptoms follow violent direct lateral force. In the *impacted* form of extracapsular fracture, in addition to the aid given the surgeon by the history, there is severe pain, which is intensified by movement or pressure; shortening to the extent of one inch at least, which is not corrected by extension; limited abduction; great loss of function; and whereas the limb may be straight or even inverted,

<sup>\*</sup> Brit. Med. Jour., Oct. 12, 1895.

it is usually everted. The trochanter is above Nélaton's line, the base-line of Bryant's triangle is shortened, but not so much as in the unimpacted form; there is no crepitus unless the impaction is pulled apart, and the arc of rotation

of the great trochanter is larger than in a non-impacted fracture.

Treatment.—In impacted extracapsular fracture it is best to pull apart the impaction if the patient is in good physical condition. Southam, of Manchester, in an impressive article, has insisted on the absolute necessity of pulling apart an impaction. He gives ether, and when the patient is anesthetized unlocks the fragments.\* This unlocking is best accomplished by abduction, the rim of the acetabulum acting as the fulcrum of the lever (Whitman). In treating non-impacted extracapsular fracture make extension, raise the foot of the bed, and apply the extension apparatus with sand-bags for three weeks and then apply a plaster dressing. Get the patient on crutches after the plaster has been in place for two weeks. Remove the plaster at the encil of four weeks. Thomas's splint may be used instead of Buck's extension or the treatment suggested by Whitman may be employed (page 597).

Fractures of the Femoral Neck in Children.—Fracture of the femoral neck in children and in young adults can scarcely be regarded as very unusual, and is certainly more often encountered than is separation of the upper epiphysis. The accident results from a fall rather than, as in an adult, from a twist, and it is the product of considerable violence rather than of slight force. In children such fractures may be impacted and most of those which are unimpacted are of the green-stick variety. The disability is not nearly so great as in an adult; in fact, it is not unusual for the victim of such an injury to be able to hobble about a few days afterward. The symptoms are shortening, some eversion, impairment of joint-movements, and a limp when the patient gets about. Fractures of the hip in children are often unrecognized and lead frequently to permanent impairment because of the development of coxa vara. The x-rays should be used in making the diagnosis.

A green-stick fracture may be treated with Thomas's splint, and after four weeks in bed "the child may be allowed up, wearing a traction hip-splint for several months until union is so firm that the danger from coxa vara is practically eliminated. A light plaster-of-Paris spica bandage from the calf to the axilla will maintain immobility after the splint is omitted" (Scudder, on "The Treatment of Fractures"). An impacted fracture, after the impaction has been pulled apart, is treated exactly as is a green-stick fracture. Royal Whitman's plan for treating a green-stick fracture is very satisfactory. This surgeon ("Med. Record," March 19, 1904) dresses these cases by placing the limb in extreme abduction and holding it so by means of a plaster-of-Paris spica (Figs. 304, 305). In a case of acute disability of the hip-joint in a child, following some time after fracture of the femoral neck, make a careful differentiation from tuberculous disease of the joint and apply a traction splint to support the body and give rest to the joint. If coxa vara becomes marked and causes great disability, osteotomy is justifiable.

Operative Treatment of Fracture of the Femoral Neck.—I have performed this once in a recent case. The patient was a woman forty-two years of age and the result was excellent (Fig. 298). The operation is not indicated

<sup>\*</sup>Lancet, Dec. 21, 1895.

in elderly subjects. It is not indicated at all if the fragments can be coaptated and retained by extension and counterextension or by abduction. In a youth or middle-aged person in which retention in correct posture is impossible it is indicated.

Some advocate incision, suture of the torn capsule, and nailing. In my case I nailed through a very small skin incision and did not suture the capsule. It is held that suture of the capsule improves the circulation in the broken off head, but possible attainment of the object is not justification for



Fig. 308.- Deformity following fracture of upper third of femur.

the risk. The small cutaneous incision and nailing answers the purpose. It is not necessary to drill the trochanter as König did.

Before operating, an x-ray picture is taken, while the fragments are brought into abduction by obstruction or by extension and counter-extension. From this picture the angle of the neck is noted and the length of nail required is determined. A silver nail is used. When ready to operate, the fragments are again brought into apposition by extension and counter-extension or abduction. An incision is made through the skin over the external aspect of the

great trochanter, and the nail is driven through the trochanter and neck into the head. The wound is closed and dressed. The pelvis and extremity are then put up in plaster, a trap-door being cut over the seat of incision. The plaster dressing is retained for five or six weeks. Cure is obtained without shortening and with retention of joint mobility. This operation is also used for uncorrected fracture. It has been advocated in certain recent fracture by G. G. Davis.

Separation of the upper epiphysis of the femoral head is a very rare result of accident; it occurs most often from disease. It is met with in carly youth, results in considerable permanent shortening, and perhaps in vara.

Symptoms and Treatment.—The symptoms are like those of fracture of the neck, except that the crepitus is soft. The treatment is as for fracture of the neck.

Fractures of the Great Trochanter.—This is a very rare injury. There seem to be only 8 cases on record, but probably the diagnosis has been missed in some cases in which the fragment was held to the bone by periosteum. This process may be (1) broken off without any other injury. In some cases it is completely broken off; in some it remains attached by periosteum and fibrous tissue. (2) The line of fracture may run through the trochanter and leave one portion of the trochanter attached to the head and neck and the other part attached to the shaft of the femur. The cause is violent direct force over and behind the great trochanter or a fall (Armstrong, in "Annals of Surgery," August, 1907). Neck reported a case due to muscular action ("Zentralb. (ur Chir.," 1903).

Symptoms and Treatment.—The symptoms of the first form resemble those of epiphyseal separation and, of course, there is no shortening. The symptoms of the second form are similar to those of extracapsular fracture. On rotating the femur the lower part of the trochanter moves with it, but not the upper. The lower fragment goes upward and backward and projects by the side of the sciatic notch. There are shortening, eversion, crepitus, and altered position of the trochanter. The treatment of the second form is like that in extracapsular fracture, and the first form is treated like

separation of the epiphysis of the trochanter.

Separation of the epiphysis of the great trochanter is a rare accident, but not so rare in youths as is fracture in adults. The cause is direct violence and the injury occurs in those under eighteen years of age. Poland in 1898 collected 12 cases.

Symptoms.—The trochanter, if completely separated, is found to have ascended and passed posteriorly; there is no shortening of the thigh; all the motions of the hip-joint can be obtained; if the thigh is flexed, abducted, and totated externally, and the fragment is pushed downward and forward, crepitus is obtained—soft in epiphyseal separation, hard in fracture. There is no shortening. If the process is not completely separated, diagnosis is impossible without the x-rays.

Trealment.—If the epiphysis is not completely separated, immobilize the limb in the position of abduction. If it is completely separated, incise the

soft parts and either suture or nail the fragment in place.

2. Fractures of the shaft of the femur may affect any portion of the shaft, but especially the middle third, and may occur at any age. Fracture of the upper third is a rare accident. Allis estimates that each year in Philadelphia there is 1 case of fracture of the upper third of the femur to every 100,000 inhabitants. Separation of the lower epiphysis occasionally occurs. The cause of fractures in the upper third is usually indirect force; fractures in the lower third are due to direct force; and in fractures of the middle third these two causes are about equally potential. Fracture from muscular action occasionally occurs. Oblique fracture is the usual variety. In many cases the soft parts are badly lacerated and sometimes a great vessel is torn.

Symptoms.—The chief symptom in fracture of the shaft of the femur is great displacement, except when impaction occurs, when the break is due to direct force, or when the injury is in a child. In a child the line of fracture is often transverse and the periosteum may be untorn. Green-



Fig. 309.—Dressing of fracture of the femur in the upper third with extension upon a double inclined plane (Agnew).

stick fractures occur in children. As a rule, in fracture of the shaft of the femur the lower fragment is drawn upward and the upper end of the lower fragment is found posterior and somewhat to the inside of the lower end of the upper fragment, and the lower fragment also undergoes external rotation (the drawing up is due to the rectus and hamstrings; the passing inward is due to the adductor muscles; the rotation outward arises from the weight of the limb). If a fracture of the lower two-thirds of the shaft is produced by direct force, there is usually but little deformity, because the line of fracture is nearly transverse. If produced by indirect force, there is often great deformity, the line of fracture being oblique. In fracture of the lower third of the shaft the gastrocnemius pulls upon the condyles and tilts the lower fragment, so that its upper end projects into the popliteal space and may damage the vessels. In fracture of the upper third the upper fragment is apt to be thrown strongly forward and outward (Fig. 308). Some attribute this to the action of the psoas, iliacus, and external rotator muscles, but Allis thinks it is due chiefly to the lower fragment pushing the upper fragment into this position, a part of the tendon of the gluteus maximus acting as a hinge for the fragments.\* In rare cases the angular deformity is backward. In

<sup>\*&</sup>quot;Fracture in the Upper Third of the Femur Exclusive of the Neck," by Oscar H. Allis, Medical News, Nov. 21, 1891.

fracture of the shaft of the femur there is complete loss of function, the thigh and leg are slightly flexed and usually everted. In somes cases the leg and lower fragment are inverted. There are shortening to the extent of two or three inches, pain on movement, preternatural mobility, crepitus, and obvious deformity, and the ends of the fragments can be felt by the surgeon. In impaction there is alteration of the axis of the limb and some shortening. Always feel for the pulse below the fracture to learn if the artery is damaged.

Treatment.—In setting and dressing a fracture of the thigh ether should be given and the parts must be handled with great care to prevent a sharp end of bone from tearing the soft parts and puncturing the skin. In fracture of the shaft of the femur, if impaction exists, the fragments must be pulled apart, when the case should be treated exactly as is a non-impacted fracture. After a fracture of the shaft of the femur some amount of permanent shortening is almost inevitable. In fracture of the upper third treatment is usually unsatisfactory, and there is permanent shortening from

angular union or from overlapping. Horizontal extension fails to correct the displacement of the upper fragment in fracture of the upper third. The double inclined plane will not correct the tilting of the upper fragment while shortening exists. Agnew used a double inclined plane and corrected shortening by the use of extension in the axis of the partly flexed thigh (Fig. 309). This plan is the most serviceable of those usually employed, but it too fails to completely correct the displacement. If, notwithstanding position and extension, the upper fragment projects, it should be pushed into place and be retained if possible by short splints bound upon the thigh. Extension



Fig. 310.-Smith's anterior splint.

should be continued for four weeks, a plaster-of-Paris bandage being used for four weeks more, the patient being then allowed to go about on crutches. Some surgeons, in fracture of the upper third, apply a plaster-of-Paris bandage to the leg, thigh, and pelvis, extension being made from the foot while the dressing is being applied. This method does not give good results because such extension will not correct the tilting of the upper fragment. The anterior splint of Nathan R. Smith is used by some in treating fractures of the upper third of the femur (Fig. 310). It is bent to the desired shape, fastened to the anterior surfaces of the leg and thigh, and hung to a gallows, the limb being suspended at the desired height. This splint is open to the same objection as the double inclined plane. In fact, in many fractures of the upper third of the shaft of the femur no apparatus will maintain reduction. In such cases it is advisable to incise, separate the muscles from between the fragments, and fasten the ends of the bone fragments together with bone

ferrules, silver wire, kangaroo-tendon, steel screws, steel pins, or a bone-clamp. This radical treatment has certain dangers of its own, but it is the only plan which promises to secure a thoroughly good limb. In *fracture* of the *middle third* or *upper part of the lower third* of the shaft of the femur, the extension apparatus and sand-bags will usually secure a satisfactory result (Pl. 6, Fig. 14). The strips of adhesive plaster are carried to



Fig. 311.-Hodgen's apparatus as applied by Dr. George S. Brown.

just below the seat of fracture, and the turns of the roller bandage should be taken to a little above this point. Extension should be continued for four weeks, when the plaster-of-Paris bandage ought to be applied. The plaster is kept in place for four weeks. Many surgeons use Hodgen's splint in treating fractures of the thigh. The limb is suspended in a cradle and extension is obtained by strapping the foot to the cross-bar of the frame and pulling upon the frame by cords (Fig. 311). Hodgen's apparatus as applied by Brown, of Birmingham, Ala., is one of the most satisfactory methods of treatment in fracture below the upper third. The extremity can be raised or lowered at will without disturbing the approximation of the fragments, extension to the required degree can be obtained, and the patient can be moved in bed. I consider this apparatus the most comfortable appliance which can be worn and excellent results are obtained by its use. In fracture of the middle third or upper part of the lower third of the shaft if the line of fracture is transverse and there is little deformity, as is seen often after a fracture by direct force, and often in children, immobilization in an im-



Fig 312,-McIntyre's splint.

movable dressing may be all that is required; but if shortening exists, extension must be used. If extension is used, continue it for four weeks and then substitute a plaster-of-Paris dressing for four weeks. The amount of weight required is pointed out by Dawbarn—one pound for each year up to twenty.\* In fracture near the knee-joint (lower part of the lower third of the femur) it may be impossible to effect reduction by horizontal traction. In such a case make traction, and while it is being made gradually bring the leg to a right angle. Place the limb in a double inclined plane (Pl. 6, Fig. 2). A McIntyre splint (Fig. 312) is a useful form of double inclined plane. After four weeks of the use of a double inclined plane apply a plaster-of-Paris dressing, which is to be worn for four weeks.

Fractures of the Shaft of the Femur in Children.—In children under three years of age the extension apparatus will not satisfactorily immobilize the fragments. Fractures of the thigh in children are reduced by extension and counter-extension; a well-padded splint reaching from the axilla to below the sole of the foot may be applied to the outer side of the limb and body. This splint is held in place by bandages which are overlaid with plaster-of-Paris. It is worn for four weeks, at which time it is removed and a plaster bandage, applied so as to include the entire limb, is worn for four weeks.

<sup>\*</sup> Annals of Surgery, Oct., 1897.

Bryant's extension is very satisfactory in treating a child (Fig. 313). Both the injured limb and the sound limb should be flexed to a right angle with the



Fig. 313.—Bryant's extension for fracture of the thigh in a child.

pelvis, fixed by light splints, and fastened to a bar above the bed. The weight of the body produces counter-extension and the child can be easily cleaned.\*

Another plan is that of Theodore Dunham.†
The child is placed upon a table, and the knee
and thigh are partly flexed. After first applying
flannel rollers, plaster-of-Paris bandages are applied from the roots of the toes to the spine of the
tibia, and as a spica about the upper part of the
thigh and pelvis. Two pieces of iron, suitably
bent, are used to anchor the two plaster bandages
together. One end of one iron is attached to the

plaster over the groin and one end of the other iron is attached to the plaster over the front of the leg. The free ends of the irons

overlap. At the points over the joints and the front of the leg where the irons are to rest masses of plaster are placed. The iron is sunk into the plaster and supported at each spot by several turns of a plaster bandage. While the irons are being adjusted the thigh is so held as to prevent bending or rotation, and the hip and knees are semiflexed. When the plaster has set an assistant makes extension on the leg and another assistant makes counter-extension by pressing on the pelvis. Any shortening is thus reduced and the two irons are lashed together with strong cord (Fig. 314).

Van Arsdale's triangular splint is a very useful appliance. It is made of binders' board. A. Ernest Gallant † describes its preparation and application as follows: Measure the length of the sound thigh from the middle of the groin to the end of the femur. Draw upon cardboard an outline of a double spade (playing-card spade) (Fig. 315). Each of the four sections (A, B, C, D) must be



Fig. 314.—Dunham's apparatus for treating fractures of the thigh in infants and children.

equal to the length of the child's thigh, the flanged portions being equal to the widest part of the thigh. The figure is then cut out. The cardboard is moistened on one side and folded on the dotted line, section A being lapped over D, so as to form a triangle. It is fastened together by adhesive plaster. The thigh is flexed and the triangle is applied so that one flanged portion embraces the thigh and the other flanged portion rests upon the abdomen

<sup>\*</sup> Thomas Bryant's "Practice of Surgery." † Phil. Med. Jour., April 23, 1898. ‡ Jour. Amer. Med. Assoc., Dec. 18, 1897.

(Fig. 318). The triangle is fixed in position by bandages, figure-of-eight turns being made around the knee and around the thigh and body. Plaster or starch

bandages are then applied to fix the splint firmly. The leg should be bandaged from the toe to the knee to prevent swelling (Fig. 318). This splint is worn for three weeks. A child wearing this splint can sit on a chair, nurse, play on the floor and crawl about, may sleep on either side, and the dressing is not soiled by the evacuations.

If a thigh is fractured during parturition, or during the first few weeks of

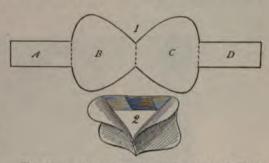


Fig. 315.—r, Diagram showing outline of Van Arsdale's splitin; the end band to be folded on the dotted lines; each section to equal the length of the child's thigh. z, Diagram, splint folded, fastened by rubber plaster, flanges bent to embrace the thigh and abdomen, ready for adjustment (Gallant).

life, Wyeth's dressing may be very serviceable. It is applied as follows: The leg is flexed on the thigh and the thigh on the abdomen. A flannel bandage is applied so as to include the leg, the thigh, and the body from the axilla to the pelvis. Plaster-of-Paris is applied over this; the dressing is worn for



Fig. 316.—Ware's combined pasteboard triangle and plaster-of-Paris spica apparatus for fracture of the femur in infancy (Ware, in "Annals of Surgery," August, 1905).

four weeks. A better dressing than the above is Ware's, a modification of Van Arsdale's splint ("Annals of Surg.," August, 1905) (Fig. 316). It is lighter, the patient can be moved about with ease, the child's toilet can be easily carried out, and breathing is not embarrassed. A right-angled triangle



Fig. 317.—Ware's apparatus for treatment of fracture of both femora (Ware, in "Annals of Surgery," August, 1905).

is made of bookbinders' board. The length of one side is the distance from the trunk at the level of the lower angle of the scapula to the inguinal fold. The length of the other side is the length of the thigh. The hypotenuse is, of course, longer than the sides. The cardboard is marked, bent into the tri-



Fig. 318.—Showing Van Arsdale's triangular splint in position. Note the wide space between the dressings and the excretory passages (Gallant).

angle, and the overlapping edges are secured by means of adhesive plaster. The thigh is flexed and abducted, the inner surface of the splint is padded, the apparatus is applied and retained by a muslin spica about the trunk and thigh. Several turns of a dextrin bandage are applied over this to give strength. The

leg hangs free. The dressing is worn for three or four weeks. Fig. 316 shows this dressing applied for fracture of the right femur and Fig. 317 shows it applied when both bones are broken.

Fractures Just above the Condyles of the Femur.-The line of fracture above the condyles is well above the epiphyseal line. The femoral artery is in danger from the fragments. The cause of the break, as a rule, is direct

violence. Indirect force is sometimes responsible (falls upon the feet). The knee-joint may be opened. The

fracture is sometimes compound.

Symptoms.—The upper end of the lower fragment is drawn upward and backward, because of the action of the rectus, hamstrings, gastrocnemius, and popliteus. The upper fragment passes inward, and the deformity is very manifest. There are shortening, crepitus, and mobility. The ends of the fragments can be felt by the surgeon. If the force has been very great, a T-fracture results. In T-fracture the knee is broadened and crepitus is obtained by moving the condyles, one up



Fig. 319.-Mechanism of fracture of the patella by muscular action (after Treves).

and the other down. Always feel for the pulse below the fracture. Treatment.—In treating fracture above the condyles, reduce the deformity by horizontal extension. If this fails, make traction at the same time, gradually bringing the leg to a right angle with the thigh. Place the limb on a double inclined plane for five weeks, then begin passive motion once every other day, restoring the limb to the splint after the movements are completed.



Fig. 320.-Fracture of the patella.

At the end of eight weeks after the accident remove the dressings, and, if the knee-joint be stiff, use for some time massage, passive motion, hot and cold douches, ichthyol inunctions, etc. Bryant treats this fracture in extension, cutting the tendo Achillis, if necessary, to amend deformity. It is occasionally necessary to wire the fragments. Some cases demand amputation because of injury to the structures in the popliteal space.

Fracture Separating Either Condyle.—The cause is direct force.

Symptoms and Treatment. - The broken piece is drawn upward, the leg bends toward the injury, crepitus exists, the knee is much broadened, there is no shortening, and considerable swelling is sure to arise. In treating a fracture

separating either condyle, use a double inclined plane as directed above. Longitudinal fractures run upward from the knee-joint. The cause is a fall upon the feet or the knees.

Symptoms and Treatment.—The symptoms of longitudinal fracture are often obscure. The femur is broadened when the knee is flexed. The split may be detected between the condyles. The treatment is the straight position in plaster for eight weeks.

Separation of the lower epiphysis occurs only before the twenty-first

year. It is not a very rare accident in children.

Symptoms.—The symptoms in separation of the lower epiphysis are like those of transverse fracture, but crepitus is moist. The lower fragment is tilted, so that the articular surface looks forward. The lower end of the upper fragment projects into the popliteal space. There is danger to the structures in the popliteal space and that the growth of bone will be stunted. Feel for the pulse in the leg or foot.

Treatment.—Reduction may be effected in some cases by horizontal extension. Occasionally this is impossible.\* In such a case adopt the plan of



Fig. 321.—Fracture of the patella (Pennsylvania Hospital case; skiagraphed by Dr. Gaston Torrance).

Hutchinson and Barnard, make extension, and while it is being made gradually place the leg at a right angle to the thigh. This is effected by an assistant making traction on the leg, while the surgeon clasps his hands beneath the lower part of the thigh and draws upward. The treatment for separation of the lower epiphysis is the use of a double inclined plane as above directed. In some cases replacement is impossible without incision. In a case of my own amputation was performed because of laceration of the popliteal vessels.

Fracture of the patella is a very common accident. The cause is direct force (often producing vertical, star-shaped, or oblique lines of fracture, but uncommonly transverse) or muscular action (producing a transverse line of fracture).

<sup>\*</sup>See the case reported by Jonathan Hutchinson, Jr., and Howard L. Barnard, Lancet, May 13, 1899.

Transverse Fractures of the Patella.—The knee-cap is more often broken by muscular action than is any other bone. When the knee is partly flexed the middle third of the patella rests upon the condyles of the femur and the upper third of the knee-cap projects above them; when in this position a contraction of the quadriceps may easily cause a fracture near the center of the bone (Fig. 319). The accident may be caused by sudden flexion of the knee when the quadriceps is contracting. The most usual cause is a fall or an attempt of the patient to save himself from a fall. Both patellæ may be broken at once. In fracture of the patella the joint, and often the prepatellar bursa, is opened. Fractures by muscular action are transverse. The



Fig. 322.-Fracture of the patella (Pennsylvania Hospital case; skiagraphed by Dr. Gaston Torrance).

injury is more common in males than in females, and is extremely rare in the very young and the old. It is an injury of active manhood and middle life.

Symptoms.—When the accident happens there is often an audible crack. As a rule, the patient will not try to use the limb, although it is possible for him to stand, to walk backward, and to move slowly forward when the extremity is kept straight. After the accident there is rapid and enormous swelling, due to the effusion first of blood and then of synovia and inflammatory products into and around the joint. The patient is absolutely unable to raise the limb from the bed. The fragments are movable and usually widely separated (Fig. 321), this separation being distinctly manifest to the touch

unless swelling is great. The separation is accentuated by flexion of the leg. The separation may be to the extent of one inch or even more. In cases in which the lateral fibrous expansions and periosteum are but slightly torn, there may be slight separation or no separation. Separation is due in part "to the retraction of the quadriceps and the tension of the fascia lata, and in part to



Fig. 323.-Transverse fracture of the patella; fractured surface partially covered by irregular flaps of torn aponeurosis (Hoffa).

distention of the joint by blood and exudate."\* If fragments are not approximated and union does not occur, the separation becomes gradually greater because of the progressive shortening of the muscle and the retraction of the ligamentum patellæ (Stimson). In some cases an anterior angular displacement occurs because of the intra-articular distention (Fig. 322). It may be produced by the pressure of bandages or strips of plaster when the fragments have been brought together. Crepitus is detected if the upper fragment can be pushed down until it touches the lower piece; but if swelling is great, or if fibrous tissue is interposed between the bones, crepitus cannot be elicited. It is not necessary to obtain crepitus in order to make the diagnosis: the condition is obvious without this sign. The anterior fibroperiosteal laver is torn, and the tear does not correspond exactly with the line of fracture. A

portion of this torn fibroperiosteal layer may, as Macewen pointed out, drop between the fragments and prevent union (Fig. 323). The lateral expansions of the capsule are usually extensively torn. If union occurs after a transverse fracture, it will probably be ligamentous, and if the patient gets about too soon, even apparently well-united fragments will by degrees stretch far asunder.

Treatment of Transverse Fractures of the Patella.-The Conservative Plan.-If the swelling is so great as to prevent approximation of



Fig. 324.-Needle specially designed to carry a thick wire. The eye is drilled obliquely, and should receive only a little loop on the end of the wire; this loop should be made previously.

the fragments, reduce it by bandaging for a day or two, by using ice-bags, or by aspirating the joint. As a rule, the blood does not coagulate for several days. After it coagulates it cannot be withdrawn by aspiration, but only by incision. When the swelling diminishes, bring the two fragments into apposition, pull them together by adhesive plaster, and put on a well-padded

\*Stimson's "Treatise on Fractures and Dislocations."

posterior splint. Carry a piece of adhesive plaster over the upper end of the

upper fragment, draw the bone down, and fasten the plaster to the splint behind and below the level of the joint. Carry another piece of plaster over the lower end of the fragment, draw the bone up, and fasten the plaster to the splint behind and above the joint. Carry a third piece over the junction of the fragments to prevent tilting. Agnew's splint admirably accomplishes this approximation (Pl. 6, Figs. 11, 12). Abandage holds the splint in place, and may be carried around the knee by figure-of-eight turns. The heel is sometimes raised upon a pillow so as to extend the leg and to semiflex the thigh, but this is not essential. Remove and reapply the dressing every few days, as it

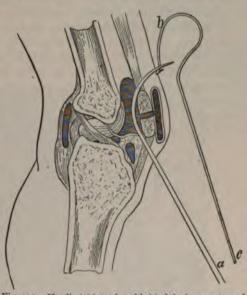


Fig. 325.—Needle (a) introduced behind the fragments, and receiving one end (b) of the silver wire (b, c) (Barker).

inevitably becomes loose. At each removal employ massage. At the end of

Fig. 326.—Needle (a) passed in front of the fragments and receiving the other end (c) of the silver wire  $(\partial, c)$  (Barker).

three weeks remove the splint permanently and apply a plaster-of-Paris dressing from just above the ankle to the middle of the thigh, and get the patient about on crutches. Have the plaster cut so that it may be easily removed and every day employ massage and gentle passive movements, the surgeon fixing the upper end of the upper fragment by his thumb during the movements. The dressing is to be worn for five weeks. After eight weeks of treatment allow the patient to walk with canes, the joint being left free at night, but kept fixed during the day for four weeks more when about on crutches, by pasteboard splints or by a light plaster-of-Paris bandage. For months after removing the splints and plaster a lacing knee-cap of leather should be worn in the daytime to support the joint. The plan of prolonged

immobilization render more or less muscular atrophy and joint-stiffness certainties, but there are less serious impediments than the wide separation

of the fragments that inevitably attends an early use of the joint. Bryant, of New York, has devised an ambulatory dressing.

Operative Treatment.—Malgaigne's hooks are obsolete.

It is said that John Rhea Barton wired an ununited fracture of the patellla in 1843. In 1877 Hector Cameron wired an ununited fracture of the patella, and a few months later Lord Lister operated on a fracture of the knee-cap two weeks after the accident. The question of the advisability of suturing a recent fracture is very much disputed. The ordinary non-operative plans of treatment do not endanger life and generally give a fairly good functional result, although the joint remains insecure on extension, the patient is apt to fall, and a fall may refracture the bone. The operative method will usually succeed,

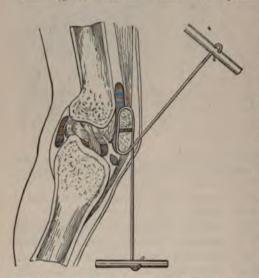


Fig. 327.—Wire in position round fragments and threaded through metal bars. The lower and posterior wire runs upward to the left of the upper, ready for twisting (Barker).

and is capable of obtaining a better functional result and of obtaining it more rapidly. There is some danger of infection, and if infection should occur, the results will be most disastrous. Some cases obviously cannot be treated by the ordinary method with any chance of success; cases, for instance, in which a flap of fibroperiosteum intervenes between the fragments, or cases in which from some other cause the bones cannot be approximated. Such cases should, of course, be operated upon. But in the great majority of cases a good result will follow conservative treatment, and conservative treatment should be trusted to unless the case is in the hands of a surgeon and in

a place where every antiseptic precaution can be taken. We agree with Stimson when he says that operative methods can be used with confidence when surrounded with every protection; he habitually uses them, but he never teaches them as proper routine practice, and strongly advises against their use except by those who have had experience in operating, who have formed the habit of taking precautions, and who have the aid of skilled assistants.\* Operation should only be performed on healthy persons of suitable age, when the separation is over one-half an inch or when there is much laceration of the capsule.† If a patient is still able to extend the limb and the lateral expansions of the quadriceps have not been widely torn, a useful limb will be obtained by conservative treatment even if the bone fragments separate, and operation is not demanded. A working man needs the operation more than a gentleman of leisure because he is in more vital need of a sound knee-joint. A young or middle-aged person is more active than an elderly person, hence, in him

<sup>\*</sup>Annals of Surgery, Aug., 1898. †Powers, in Annals of Surgery, July, 1898.

operation is more strongly indicated than in an elderly man. Barker believes strongly in wiring recent transverse fractures. He does it with antiseptic care soon after the accident, and permits passive motion or even slight active motion immediately after the operation. Massage is begun the day after the operation, and is practised daily for two weeks.

Barker\* uses a special needle (Fig. 324) and silver wire of the thickness of a No. 1 English catheter. This wire is straightened and softened in a spirit-flame.



Fig. 328.—Wired fracture of the patella (St. Joseph's Hospital case; operated upon and skiagraphed by Dr. Nassau).

He rubs the bone fragments together in order to dislodge blood or fibrous material, and when marked grating occurs, introduces the wire. A puncture with a small knife is made through the middle of the upper attachment of the patellar ligament. The needle, not carrying any wire, is made to enter through this opening into the joint, is passed back of the fragments, pierces the tendon of the quadriceps at the upper edge of the upper fragment, and its point is cut upon with a knife. The wire is inserted into the eye of the needle and the needle is withdrawn and unthreaded. The empty needle is pushed through the lower opening, is carried in front of the patella, is made to emerge at

<sup>\*</sup>See the objections of Sir William Stokes to Barker's method, in Brit. Med. Jour., Dec. 3, 1898.

the upper opening, is threaded with the protruding wire and withdrawn (Figs. 325, 326). The wires are threaded into bars and twisted (Fig. 327), the ends are cut off, and antiseptic dressings are applied. There are objecttions to Barker's operation: It does not allow us to remove blood-clots from the joint; if a bit of tissue intervenes between the fragments, it cannot be removed; and a foreign body is left permanently in the joint.\* If an operation is thought advisable, we deem it best to do an open operation, making a semilunar or a central longitudinal incision, freeing the joint from bloodclots by irrigation with hot salt solution, removing all tissue from between the fragments, drilling the fragments, passing silver wire, twisting the wire and drawing the fragments together, and closing the wound (Fig. 328). Instead of wire, silk may be used. In cases in which there is no very strong tendency to separation the fragments can be held together by several catgut sutures through the periosteum at the fractured edges or by a strong catgut suture passed through the ligamentum patellæ and the quadriceps tendon and carried in front of the fracture (Stimson). The limb should be placed on a posterior splint. In seven or eight days the superficial sutures are removed and a plaster-of-Paris splint is applied. In a few days the patient gets about on crutches. In a month the dressing is cut down the front and worn only in the daytime, and passive motion is begun. The splint is discarded at the end of the third month.† Among other operative procedures we may mention the following: Encircling the fragments with a silk suture (the circumferential suture). This suture may impair bone nutrition and retard union. Ceci drills the bones subcutaneously and passes wire through the drill-holes in the form of a figure-of-eight. Passing subcutaneously a ligature around and over the fragments (Butcher). Incision and approximation of the fragments by fixationhooks or metal pins.

Fractures of the patella by direct force are vertical, stellate, oblique, V-shaped, or transverse; are often incomplete and occasionally compound or comminuted. Ransahoff maintains that fractures from direct force are more common than from muscular action and are usually transverse and associated with some comminution ("Jour. Am. Med. Assoc.," Oct. 13, 1906).

Compound fracture of the patella is very rarely seen in Philadelphia hospitals. The records of the Boston City Hospital (an institution in which multitudes of fractures are treated) show only 8 compound fractures of this bone in forty-two years (Scannell, in "Boston Med. and Surg. Jour.," Nov. 15, 1906).

Symptoms.—Fractures of the patella by direct force are followed by discoloration, swelling, great difficulty in movement, and much pain. There may or may not be crepitus. The degree of separation of the fragments depends upon the direction of the line of fracture and the extent of bone involved. Bony union is apt to occur after such a fracture.

Treatment.—A fracture resulting from direct force may often be treated with a posterior splint and the application of a bandage. If there is any separation, the fragments should be approximated by adhesive strips, bandages, and compresses. At the end of three weeks remove the posterior splint, apply a plaster-of-Paris splint, and get the patient about on crutches. The danger in these cases is ankylosis rather than non-union; hence, in the fourth week, cut the plaster splint down the front and begin passive motion of the knee-joint.

<sup>\*</sup>Brit. Med. Jour., April 11, 1896. †Stimson, Annals of Surgery, Aug., 1898.

At the end of six weeks cease wearing the dressing in the daytime, and at the end of three months discard it entirely. In those rather unusual cases, in which an oblique fracture with wide separation arises from direct force, treat as advised for transverse fracture from muscular action. The question of operation is practically the same as for transverse fracture from muscular action. In every compound fracture of the patella, if amputation can be avoided, incise the soft parts freely and irrigate the joint with hot saline fluid. Remove hopelessly loosened fragments. Those not completely separated may in some cases be sutured into place. Drain twenty-four or forty-eight hours.

Ununited and Badly United Fracture of the Patella.—There is usually a band of union, but it may be very thin and the fragments may be far asunder. It is commonly taught that the degree of functional impairment depends directly on the amount of separation. This is not strictly true. There may be great separation and but little impairment of function, the fragments being firmly united with a dense fibrous band. There may be little separation and yet lameness, stiffness of the joint, and imperfect power of extension. The reason for this has been pointed out by Bruns, of Tübingen.\* He says there may be complete failure of union, even when the separation is trivial, and failure of union produces impaired function. If separation is considerable, the fragments are apt to tilt and tissue is often interposed between them. Functional difficulty is more often met with when the fragments are far apart than when they are near together, because non-union is more common. Even if non-union occurs, in some cases the quadriceps is still able to act upon the tibia by means of the fascia lata, ligaments at the sides of the joint, or bands from the vasti to the lower fragment. Besides non-union, functional impairment may be due to anchoring of the upper fragment to the femur. The upper fragment is anchored to the femur by the interposition of the fibrous investment of the knee-cap, which covers the fractured surface of the upper fragment and grows fast to the capsule of the joint (Bruns).

The treatment of ununited and badly united fracture is discussed on page 538.

Fractures of the Leg.—In leg-fractures both bones or only one bone may be broken.

Fractures of the tibia are divided into (1) fractures of the upper end; (2) separation of the upper epiphysis; (3) fractures of the shaft; (4) fractures of the lower end; and (5) separation of the lower epiphysis.

Fractures of the upper end of the tibia are uncommon. They may be transverse, oblique, or vertical, running into the joint. The cause is direct violence.

Symptoms.—In fracture of the upper end of the tibia there is contusion of the soft parts. In a transverse fracture there are mobility and crepitus, but there is little displacement. In oblique fracture crepitus and mobility are marked, the axis of the limb is altered, and the fragment may be displaced. In fractures entering the joint there is great swelling of the knee-joint. In comminuted fractures, which exhibit marked signs, union is readily obtained, but if the joint has been damaged, stiffness is sure to ensue.

Treatment.—Reduce displacement by extension and manipulation. The special apparatus used depends on the case. In some cases extension is re-

<sup>&</sup>quot;Beiträge zur klinischen Chirurgie," "Mittheilungen aus der chirurg. Klinik zu Tübingen," Bd. iii, Heft 2, 1888.

quired, in some a posterior splint is applied and the limb is suspended from a gallows, in some a double inclined plane is employed, and in some a plaster-of-Paris splint is used.

The double inclined plane in the form of McIntyre's splint is frequently employed, or a double inclined plane in the form of a fracture-box may be preferred. The extremity should be immobilized for four weeks, when passive motion should be begun. Passive motion is to be made daily, the dressing being reapplied after each séance. In five or six weeks the dressings are removed and the patient allowed to go about on crutches. The crutches are soon abandoned for a cane, and later all support is dispensed with. If a fracture extends into the knee-joint and the ill-adjusted fragments block the articulation, the joint should be opened and the fragments placed in proper position.

Separation of the tubercle of the tibia is due to violent contraction of the quadriceps, and occurs only in those under twenty years of age. The fragment is drawn up and can be felt, and the patient is unable to use the limb. In a case in which the tibial spine has been torn off, the limb should be placed on a posterior straight splint and the fragment should be pulled down into place by adhesive strips and bandages. The splint should be worn for five weeks.

Avulsion of the Spine of the Tibia.—This is a very rare accident. There are but 4 cases on record, and in only 1 of them (Pringle's) was the diagnosis made during life, and it was made in that case by exploratory incision. The tibial spine is torn off by the anterior crucial ligament. The causative force is probably flexion, abduction, and internal rotation of the leg (J. Hogarth Pringle, "Annals of Surg.," August, 1907). After the accident the leg at the knee is in extreme abduction. Exploratory incision may be necessary for diagnosis. The treatment is to suture the bone fragment into place.

Separation of the Upper Epiphysis of the Tibia.—This is an injury of extreme rarity. It does not seem to occur after the sixteenth year. It is caused by a twist or by violent abduction or adduction of the leg. It may lead to lessened growth of the limb. The treatment is as for a fracture of the

upper end of the bone.

Fractures of the Shaft of the Tibia.—The causes of these fractures are direct force, indirect force, or torsion. A fracture in the upper part of the bone is usually transverse; in the lower part it is usually oblique (T. Picker-

ing Pick).

Symptoms.—In transverse fracture of the shaft of the tibia there is no deformity, and the support of the fibula may even permit of walking; there is fixed pain; there may or may not be inequality of the fragments felt by the finger; and there are crepitus, mobility, and often linear ecchymosis. In oblique fractures there usually exist crepitus, a little mobility, and distinct deformity. The deformity depends on the direction of the line of fracture, and, as this line is usually from above downward, inward, and a little forward, the lower fragment usually passes behind the upper fragment and rotates inward.

Treatment.—In treating fractures of the shaft of the tibia effect reduction by making extension from the foot and counterextension from the knee, the knee-joint being in partial flexion. If there is much swelling, put the limb in a fracture-box (Figs. 329, 330, and Pl. 6, Fig. 1), swing the box from a

gallows, and apply an ice-bag for a day or two. A silicate of sodium or a plaster-of-Paris dressing is applied when the swelling subsides, or the dressing may be used at once instead of a fracture-box if swelling is slight. As soon as the limb is immobilized in a silicate or plaster dressing the patient gets about on crutches. The dressing is removed after five weeks, and the patient goes about for one week on crutches, lightly using the foot, and then for a time walks with the aid of a cane. At the end of eight or nine weeks the cane may often be dispensed with, the amount of use of the leg being daily augmented.



Figs. 329, 330.—Fracture-box in fractures of the bones of the leg.

Mall colus.—The cause of fracture of the inner malleolus is direct force or traction upon the internal lateral ligament.

are some downward displacement, depression above the ends of the fragments, mobility, and crepitus. The treatment is to push the fragments into place and se side-splints or a fracture-box for two weeks, when a plaster-of-Paris or a silicate dressing may be substituted and the patient be ordered to use court ches. Remove the plaster four or five weeks after it is applied, and direct the patient to gradually bear his weight upon the leg, as outlined above.

Separation of the lower epiphysis of the tibia is a rare accident, but

is commoner than separation of the upper epiphysis. The treatment is a fixed dressing for six weeks.

Fracture of the fibula alone is commoner by far than is fracture of the tibia alone. Fractures in the upper two-thirds, which are rare, are usually due to direct force. Fractures in the lower third are frequent, and arise from indirect force.

Fractures of the Upper Two-thirds of the Fibula.—In these fractures the cause is direct force.

Symptoms.—In fracture of the upper two-thirds of the fibula the patient



Fig. 331.—Pott's fracture. Dupuytren's splint. Note length of splint; position of straps; arrangement of padding; space between foot and splint (Scudder).

is frequently able to walk. The bone is deeply situated, and displacement cannot often be detected. There is a fixed pain, which is intensified by movement and by pressure. Pressure upon the lower fragment does not move the upper fragment. Crepitus is sometimes obtained, and a linear ecchymosis is apt to appear. The bone is normally elastic, hence slight mobility is of no value diagnostically.

Treatment.—In treating a fracture of the upper two-thirds of the fibula apply a plaster-of-Paris or a silicate bandage and direct that it be worn for five weeks. Weight is not to be put upon the foot for six weeks after the accident.

Fractures of the Lower Third of the Fibula.—In these fractures the cause is indirect force, especially twists of the foot. Forcible inversion of the foot pulls upon the external lateral ligament and the external malleolus, forces the fibula outward, and tends to break it, the lower fragment being displaced outward. Forcible eversion pulls the internal lateral ligament off from the inner malleolus (often breaks the malleolus) and fractures the fibula above the ankle, the bone being displaced inward.

Pott's Fracture.—By the term Pott's fracture is meant a fracture of the lower fifth of the fibula produced by eversion and abduction of the foot. Stimson points out that the production of Pott's fracture is often aided by the weight of the body. The lesions which arise

depend upon whether the chief force is eversion or abduction. "If eversion is the sole, or main, movement, the force is exerted through the internal lateral ligament and breaks the internal malleolus squarely off at its base; then it presses the external malleolus outward, rupturing the tibiofibular ligament, and breaks the fibula close above the malleolus. Sometimes instead of pure rupture of the tibiofibular ligament there is avulsion of the portion of the tibia to which it is attached."\* Stimson further points out that if abduction is the preponderat-

<sup>\*&</sup>quot;A Practical Treatise on Fractures and Dislocations," by Lewis A. Stimson.

ing force there is an oblique fracture of the anterior portion of the internal malleolus or more frequently rupture of the anterior portion of the internal lateral ligament. There are, as in the former case, rupture of the tibiofibular ligament and an oblique fracture of the fibula several inches above the external malleolus. It is evident that the degree of injury produced by eversion and abduction depends on the point at which the force is arrested. It may be arrested after the inner malleolus has been separated or the anterior fibers of the deltoid ligament torn, and in this case the tibiofibular articulation remains intact and the fibula is not broken. It may cease after separating the tibiofibular articulation, and in this case too the fibula escapes. It may be continued until the fibula breaks. In this fracture the astragalus passes outward, somewhat backward and also upward, the later deviation being due to separation of the tibiofibular articulation.

Symptoms.—The foot is displaced outward, and a little backward and upward, and the inner malleolus or the tibia from which it was torn is extremely prominent. There is great lateral mobility and often anteroposterior mobility at the ankle-joint. Stimson points out that there are three points where pressure is certain to provoke pain: in front of the tibiofibular ligament, at the base or anterior border of the inner malleolus, and over the seat of fracture through the fibula.

Treatment.—Thorough reduction is of the greatest importance. If thorough reduction is effected, a good result will probably be obtained; but if thorough reduction is not effected, the patient will be permanently crippled to a greater or less extent. In order to effect reduction it may be necessary to anesthetize the patient. The deformity is corrected "by pressing the calcaneum forward and inward; the hand is placed against the back and outer side of the heel and pressed forward and then forcibly inward." \*

Some surgeons, at once after reduction, apply a plaster-of-Paris bandage. This treatment is objectionable because the deformity may be partially reproduced after the application of the dressing, the surgeon being unable to see it and unable to correct it.

If there seems to be no strong tendency to a recurrence of deformity, a fracture-box can be used. After reducing displacement in such a case, place the limb in a fracture-box containing a soft pillow. A bird's-nest pad of cotton or oak um is made for the heel (Figs. 329, 330). A fillet around the ankle fastens the foot to the foot-piece of the box; a pad of oak um rests between the foot-piece and the sole. A compress is placed below the outer malleolus and another one above the inner malleolus. Close the sides of the box and tie them together with a bandage, and swing the box on a gallows. Every day let down the sides of the box and rub the leg, the ankle, and the foot with alcohol. In ten days apply a plaster-of-Paris bandage and let the patient get about on crutches. Remove the plaster at the end of the fifth week after the accident, and let the patient go about with crutches for one week and with a cane for a week long.

am accustomed to dress most cases of Pott's fracture with a Dupuytren spline. This is a straight splint (Fig. 331 and Pl. 6, Fig. 9) which reaches from the head of the tibia to below the sole of the foot. This splint is padded, and a pyramidal pad with the base down is laid upon the inner surface of

<sup>\*</sup>Stimson's "Practical Treatise on Fractures and Dislocations."

the leg, above the inner malleolus, the splint being put upon the inner surface of the leg, over the pad. The splint is fastened as shown in Plate 6. Fig. 9, and Fig. 331. If the short splint shown in Plate 6 is used, the leg is semiflexed upon the thigh and is laid upon the outer surface on a pillow. After ten days apply the plaster-of-Paris bandage, which is to be worn as above directed. Bryant treats Pott's fracture with a posterior splint, two lateral splints, and a swing. Stimson uses a posterior and lateral splint of plaster-of-Paris. This splint does not slip, as may Dupuvtren's dressing. and does not hide the seat of fracture from view as does complete encasement with plaster of Paris. It is a most useful dressing. I have given above the conservative treatment of Pott's fracture. I have come to the conclusion that operation should be the rule in this injury and not the exception. The fracture is so often followed by pain, swelling, and disability, pain and disability are so largely due to malunion or fibrous union of the broken malleolus, and it is so easy to fix the fragment in place by sutures, that the conclusion seems obvious that in proper subjects operation should be performed. As Heath and Selby show, in an important article ("Annals of Surg.," Jan., 1908), operation allows us to return the tibialis posticus to its normal position and thus flat-foot is prevented. The plan suggested by Heath and Selby is excellent (Ibid.). The fragment may be sutured in place by silver wire or chromic gut. If the tendon of the posterior tibial is displaced, the torn annular is sutured to replace the tendon, a drain of rubber tissue is carried down to the bone, and the soft parts are sutured. The parts are dressed and a fixation apparatus is applied. The drain is removed in twenty-four hours. In eight weeks he should be walking freely (see cases reported by Heath and Selby, "Annals of Surgery," Jan., 1908). Pott's fracture may be compound, a portion of the inner malleolus or of the tibia projecting through the wound. If it is necessary to introduce through-and-through drainage, the foot must be placed and kept at a right angle to the leg. If a compound fracture exists, the malleolus must be nailed in place or sutured by silver wire or chromic gut. In a reported case the wire was passed through the joint and around the fragment, and the result was good.\* Nailing seems a better plan.

Fracture of both bones of the leg is a very common injury, is often compound, and is not unusually comminuted. Fractures by direct force, such as blows or kicks, are commonest in the upper half of the leg. Fractures by indirect force, as by falls, are commonest in the lower half of the leg. In fractures from indirect force the tibia breaks first, and then the fibula breaks at a higher level. The point of greatest liability to fracture from indirect force is the junction of the lower and middle thirds. Fractures of the leg are usually oblique, but they may be transverse if arising from direct force. Spiral, torsion, or V-shaped fractures and longitudinal breaks sometimes occur. In oblique fractures, as a rule, the line of fracture runs from behind, downward, inward, and a little forward.

Symptoms.—Fracture of both bones of the leg is easy of recognition. The fibular fracture is detected as before described. By running the finger along the crest of the tibia displacement will be found, except in transverse fractures, when it may not occur. The common displacement is for the lower fragment to ascend and pass behind the lower end of the upper frag-

<sup>\*</sup> Rev. de Chir., vol. viii, 1888.

ment and to rotate a little outward, and for the upper fragment to project in front. The ascent of the lower fragment is due to the action of the gastrocnemius and soleus muscles. If the line of fracture is in a direction the reverse of that which is usual, the lower fragment ascends in front of the lower end of the upper fragment. In fracture of both bones of the leg there are marked mobility and crepitus, severe pain, and inability to walk. In fractures from direct force there is more or less damage to the soft parts. A fracture of the shaft of the tibia near the ankle is distinguished from a dislocation by the fact that the deformity is easily reduced, but tends to recur in the fracture, and, further, that in a fracture the relations of the malleoli to the tarsus are unaltered, whereas in a dislocation they are altered.

Treatment.-If the fracture is near the ankle-joint, the action of the tendo Achillis may maintain deformity, and in such cases the tendon should be divided. In treating a simple fracture of the lower two-thirds of the bones reduce by extension and counter-extension, and use a fracture-box (Figs. 320, 330), though the compresses used in Pott's fracture are not required. If the soft parts are bruised, use an ice-bag for a day or two; if they are abraded, apply antiseptic dressings. The fracture-box should be swung upon a gallows. After three weeks apply a plaster-of-Paris or silicate of sodium dressing and let the patient sit up in a chair daily for one week; at the end of this time the patient may get about with crutches. At the end of six weeks after the accident remove the plaster, and let the sufferer go about on crutches for two weeks and with a cane for two weeks more. Brinton dresses a fracture of both bones of the leg for two weeks in a fracture-box, for two weeks in side-splints made of metal, and for two weeks in an immovable dressing, allowing the patient to get about on crutches as soon as the plaster is put on. Instead of the fracture-box, we may use a posterior splint, two lateral splints, and a swing. Nathan R. Smith's anterior splint is used by some in the treatment of fractures of the leg. Many surgeons apply plaster-of-Paris in the form of an ambulatory dressing. In this dressing a solid apparatus reaches to the lower third of the thigh and below the sole of the foot. When the patient walks the weight is transmitted to the thigh (Figs. 248 and 249). In fractures of the upper third of the leg the McIntyre splint or the double inclined plane is used. If the fracture is compound, ase Dricize thoroughly, make a counter-opening, insert a drainage-tube, dress with bichlorid gauze, apply a plaster bandage, and cut trap-doors over the operaings of the tube (see Fig. 253), or dress with the bracketed splint and plaster-of-Paris (Fig. 254). Remove the tube, as a rule, in about forty-eight hours; but the patient's temperature is the guide, not time of retention.

Fractures of the bones of the foot are rather rare accidents, although not so unusual as we once thought, for the x-ray has taught us that a considerable number of supposed sprains are in reality fractures. Owing to the number of the bones and to the elasticity of their connections, the force of blows and falls is spread and dissipated. The bones most often broken are the astragalus and the os calcis. Fractures from direct force are often compound. The cause of fracture of either the scaphoid, the cuboid, or one of the cuneiform bones is direct force. Simple fractures of the os calcis and astragalus may arise from crushes or twists of the foot, but result, as a rule, from indirect force, such as falls. The calcaneum may be broken by a direct blow. In rare instances the os calcis has been broken by con-

traction of the great calf-muscles. Forcible dorsal flexion of the foot may fracture the neck of the astragalus (Eisendrath). Compound fractures

may result from gunshot-wounds, crushes, and falls.

Symptoms.—The history of the nature of the accident is of great importance. In fracture of the os calcis there are severe pain, swelling, crepitus, mobility, often an apparent widening of the bone, and not unusually a loss of the arch of the foot (Pick). In some cases the posterior fragment is drawn up by the calf-muscles, and in other cases there is deformity. In fracture of the astragalus displacement may occur which resembles that of a dislocation. Crepitus may or may not be detected. It can be elicited, as a rule, by rotating the foot while the heel is firmly held. If crepitus cannot be detected, we are not certain that a fracture is present, even though the patient may be unable to stand and there are swelling and pain on pressure. The malleoli may seem on a lower level than normal if the astragalus and os calcis have been crushed. Sometimes the foot is shortened, and perhaps the fragments have been dislocated (Eisendrath, in "Annals of Surg.," March, 1905). The x-rays will make the diagnosis certain. Fractures of the other bones are difficult of detection except by the x-rays. There may or may not be crepitus, which, if it exists, is hard to localize; there is pain on standing and on pressure, and there is bruising of the soft parts.

Treatment.—In simple fracture of the os calcis and astragalus without displacement place the foot at a right angle to the leg and apply a plaster cast. This is cut down the front so that it may be removed easily. On the third or fourth day follow Eisendrath's advice and begin massage to reduce swelling and prevent muscular atrophy ("Annals of Surg.," March, 1905). The cast is worn for eight weeks, when the patient may begin to put weight upon the extremity. If a flat foot has resulted from the accident, a support must be worn (page 759). If there is displacement in a simple fracture of the os calcis or astragalus it is wisest to operate. Perfect correction is not possible otherwise and no apparatus is satisfactory. The fragments are restored after incision and may be nailed or wired in place. A fragment may require removal or the badly splintered bone itself may have to come away. If the tendo Achillis is torn loose, it should be sutured to the os calcis (Eisendrath). Fractures of the other bones of the tarsus are almost always compound, and the injury may require drainage and immovable dressing, excision of bones, or even amputation. If they are not compound, they may be treated by a plaster-of-Paris dressing or may require incision

Fractures of the metatarsal bones are almost invariably due to direct force and are almost always compound. Robert Jones has published skiagraphs of a fracture of the fifth metacarpal bone from indirect force. Crepitus may be absent because of impaction or fixation by interosseous ligaments. Jones says such a fracture may be produced by the pressure of the bodyweight on an inverted foot the heel of which is raised ("Annals of Surgery," June, 1902). When only one bone is broken, displacement is slight, there is severe pain on motion and pressure, and crepitus can generally be obtained. Pain is produced by flexing the toes, putting weight upon the toes, as in walking, and by inverting or everting the foot. Fracture of the third metatarsal is apt to destroy the arch of the foot. A simple fracture of a meta-

tarsal bone is treated by an immovable dressing for four weeks. Fractures from crushes usually demand excision or amputation.

Fractures of the phalanges of the toes are due to direct force and are often compound. They may require immediate amputation.

Treatment.—In a compound fracture where amputation is unnecessary, drain with strands of catgut for forty-eight hours and dress antiseptically, at the end of this time apply over the bichlorid gauze a gutta-percha or a pasteboard splint extending from beyond the end of the toe to well up upon the sole of the foot, and fix the splint in place with a spiral bandage of the toe and instep. The splint is to be worn for four weeks. In a simple fracture fasten the injured toe to an adjacent toe or toes by a plaster bandage and wear the dressing for three weeks.

## DISEASES OF THE JOINTS.

Synovitis is a primary inflammation of the synovial membrane alone. If other structures besides the synovial membrane are involved, the condition is known as "arthritis." Two forms of simple synovitis exist—namely, acute and chronic. Some surgeons speak also of subacute cases.

Acute Simple Synovitis.—The causes of acute simple synovitis are contusions, sprains, twists, and overuse. The causative influence of exposure to cold or damp has been much debated. It seems probable that in some cases cold produces vasomotor paresis of the vessels of the synovial membrane, a condition which may be followed by inflammation. In synovitis the synovial membrane is red and swollen, and the joint contains an excess of turbid fibrinous fluid. If the inflammation advances, arthritis arises and sometimes blood is effused.

Symptoms.—A prominent symptom of acute synovitis is pain, which is increased by motion of the joint, by pressure upon the articulation, and by a dependent position of the limb, and which is worse at night. Pressure upon the cartilage does not cause pain, but friction of the synovial membrane at once develops it. The patient places the limb in the position which gives the greatest ease, and the part becomes more or less fixed in this position because the muscles about the joint are rigid. A fluctuating swelling is noted in a superficial joint, most marked between the ligaments, which swelling bulges out the synovial area and hides or obscures the articular heads of the bones. The swelling is due early to excessive secretion of synovia, and later to effusion of liquor sanguinis. Bulging takes place at points where the capsule is thin, and at such points fluctuation may be detected. Fluctuation in the elbow is sought for posteriorly. Fluctuation in the knee is sought for on either side in front. A large effusion in the knee floats the patella up from the condyles (floating patella). A small effusion in the knee can be detected by Fiske's plan, which is as follows: Tell the patient to bend forward at the hips, resting each hand on the front of the corresponding thigh. The anterior structures of the joint are thus relaxed, and, by tapping the Patella, even a small effusion can be discovered. Bulging cannot be disfindly recognized in the hip or shoulder, unless effusion is great. The skin over the joint is rarely reddened, but feels hot to the hand of the observer (over superficial joints, but not over the shoulder and hip); the joint is partly flexed; fever exists, varying in degree with the size of the joint, the acuteness of the attack, and the nature of the cause. Suppuration rarely follows simple synovitis, but it may do so, the area of synovitis being a point of least resistance to organisms carried by the blood or lymph. If suppuration takes place, rigors occur, there is a septic temperature, and the joint soon gives evidences of containing pus. These evidences are violent pain, increased tenderness, dusky discoloration if the joint be superficial, greater muscular spasm, periarticular edema, and constitutional symptoms of sepsis. Traumatic synovitis without infection tends toward cure without suppuration if the patient is healthy, and after it ankylosis is rare.

Treatment.—In treating acute synovitis immobilize the joint. In severe cases place it in such a position that the limb will still be useful even if ankylosis occurs. In mild cases immobilize in the position of rest, apply leeches, and use the ice-bag or the Leiter coil. After a day or two apply gentle pressure, intermittent heat, and iodin and ichthyol. If the effusion is very great and persistent, and pressure, heat, and sorbefacients fail to remove it, aspirate with aseptic care. If effusion recurs after aspiration, apply plaster-of Paris dressing or use flying blisters and massage. A rubber bandage is often useful toward the termination of a case.

Chronic Synovitis.—Chronic synovitis follows acute synovitis or it may be chronic from the start. Many cases called chronic synovitis are in truth tuberculous disease. The synovial membrane looks nearly natural, but is edematous, and the joint contains an excess of fluid. If the quantity of fluid is large, the disease is called "hydrops articuli," or "dropsy." A large amount of fluid in the knee-joint "floats" the patella upward. Tuberculous infection is apt to occur in very prolonged cases. In prolonged chronic synovitis the synovial membrane thickens in some places, softens in others, is often adherent, and the villous processes hypertrophy. If the membrane becomes extensively softened (pulpy degeneration), the softened areas bulge and caseation eventually occurs. In the knee-joint a traumatic synovitis is sometimes linked with inflammation of the semilunar cartilages. Roux tells us that this inflammation may be produced by a squeeze, a twist, or a direct force, but a squeeze is the common cause. Hyperextension of the knee may squeeze the cartilage, and so may attempting to rise from a stooping posture.\* If this injury has taken place, the disability will be prolonged.

Symptoms.—In chronic synovitis pain is absent or is only present during exercise or from pressure, and is slight even then; there is some limitation of movement; passive motion may develop creaking or joint-crepitus; fluctuation is apparent and there is atrophy in the muscle about the joint. The atrophy of the muscles associated with an inflamed joint is a reflex atrophy and is named after Charcot. The hypodermatic needle will draw out a viscid, straw-colored or bloody fluid.

Treatment.—Rest and pressure are of great service. Pressure may be obtained by the application of Martin's rubber bandage. A plaster-of-Paris dressing is probably the best way to combine rest and compression. Massage, douches, frictions, passive movements, and flying blisters should be used. Painting the joint with iodin and spreading over it blue ointment, and rubbing in ointment of ichthyol (50 per cent. with lanolin) may do good. Counter-irritation by the actual cautery is a valuable expedient. The Bier treatment (page 116) is often of benefit. Chronic synovitis is often greatly bene-

<sup>\*</sup>Gaz. des Hôp., No. 125, 1895.

fited by the use of a hot-air apparatus. The limb is wrapped in flannel and is placed in an oven. The oven is heated by Bunsen burners. The temperature is raised to 250° or even 300° F., and the limb is subjected to this for one hour. The oven should be used daily, and as the patient becomes accustomed to it even a higher degree of heat can be tolerated. This high degree of heat can be borne only when it is perfectly dry. Any moisture scalds the patient. The Lentz oven has in it ventilation openings to get rid of moisture and the sweat is taken up by the flannel. This flannel must not be applied so thickly as to keep the heat notably from the joint, nor must so little of it be used as to permit of its soaking with sweat. Fig. 332 shows the Sprague hot dry-air apparatus, and Fig. 333 exhibits a cross-section of the same ap-

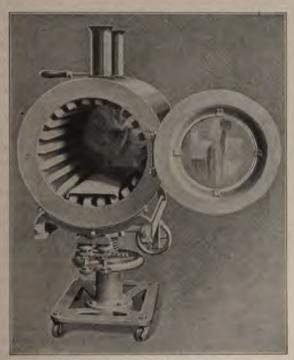


Fig. 332.—Sprague hot dry-air apparatus.

Dr. H. A. Wilson inserts in the oven humidin, a product obtained in the purification of salt, which material entirely absorbs the moisture. Cotton mot be used to wrap the limb, because, if the bottom of the oven bestored hot, the cotton may ignite and burn the patient. A physician or nurse should constantly watch the apparatus during its employment.\* Aspiration and the subsequent use of a plaster-of-Paris bandage may be tried in some cases of chronic synovitis. Some surgeons advise aspiration, washing out with salt so ution, injecting a 5 per cent, solution of carbolic acid, and immobilizing. In cision and drainage constitute a radical but proper plan in cases unamended by simpler methods. If pulpy degeneration exists, perform an ex-

\* H. A. Wilson, in Annals of Surgery, Feb., 1899.

cision or an erasion. If pus forms, incise at once and drain. Internally, treat any existing diathesis and give nutritious food, tonics, and stimulants.

Arthritis.—By this term is meant not only inflammation of a synovial membrane, but also of other structures composing and surrounding a joint. It may follow traumatic synovitis; it may be due to pus-organisms, to tubercle bacilli, to infectious diseases (gonorrhea and typhoid fever), to rheumatism, to gout, to syphilis, and to lesions of the spinal cord. Arthritis may be either acute or chronic.

Tuberculous Arthritis (White Swelling; Strumous Joint; Pulpy Degeneration).—Pathology and Symptoms.—The predisposing causes of tuberculous arthritis may be strains, blows, twists, or cold. The real cause is the tubercle bacillus. A single joint is attacked. Other joints may subsequently become involved so that several suffer simultaneously, but it is rare that the process is active in more than one joint at the same time. During the course of tuberculous disease of a joint (except of the shoulder-joint) phthisis is not common, although it not unusually develops after the joint gets well. The same is true of tuberculous glands. During the existence of phthisis or tuberculous glands tuberculous arthritis does not frequently arise. The primary infection with tubercle bacilli is usually in the bone, though it may be in the synovial membrane, the joint-capsule, or the structures about the joint. The frequency of the bony origin

of tuberculous arthritis is shown by Murphy's statement that in

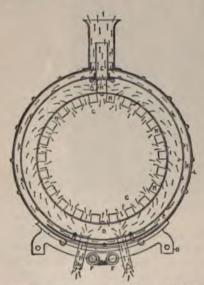


Fig. 333.—Cross-section of Sprague hot dryair apparatus: A, A, Air intakes; B, circulating air space; E, jacketed space for products of combustion; G, treatment chamber; M, M, cork ribs; N, N, perforations admitting heated air; O, base holding apparatus; P, P, gas-burners.

128 cases of tuberculosis of the knee it was demonstrated in all but 2 that the condition originated in the bone (John B. Murphy, in "Jour. Am. Med. Assoc.," May 20-27, June 3, 1905). If the primary infective focus is in the bone, a portion of the cartilage is destroyed and the joint is opened, or a sinus forms and perforates the synovial membrane. When tuberculous inflammation attacks the synovial membrane granulation tissue is formed, and the capsule and periarticular structures soon become involved in the process; the parts thicken and soften from caseation, and they may be covered with tubercles, though but little fluid is usually effused into the joint. Some few cases present large joint effusions, but in most cases fluctuation is absent. Capsular thickening may or may not be manifest. Soon after tuberculous

arthritis begins the joint becomes rigid, irritation having induced muscular spasm. This reflex rigidity fixes the joint more or less completely, and atrophy of the rigid muscles soon begins. There is usually pain

in tuberculous arthritis, but it may be referred to a distant part. For Instance, in hip-joint disease the pain is often referred to the inner of the knee, and in Pott's disease of the spine the pain may be referred to the abdomen. Attempts at motion demonstrate the limitation of movement due to muscular rigidity and also produce pain. A child that suffers from a tuberculous joint is apt to be restless in sleep, moaning and tossi s, and to wake at times crying out in terror (night-cries and nightterrors). In the ordinary form of tuberculous arthritis there occurs what is known as "gelatiniform degeneration"; the granulation tissue is formed in large amount as fungous growths; the structures are markedly edematous and softened; the relaxed ligaments yield under pressure; the natural contour of the joint is lost, and it becomes spindle-shaped; all the structures, articular and periarticular, are glued into one mass; the skin about the joint is white, thick, and adherent, and in it one or more large veins are seen; fluctuation or pseudo-fluctuation is noted when caseation has occurred; pain is not of ten severe, but it can usually be elicited by certain motions or by firm pressure, but the pain will always be severe when the epiphysis is involved; the temperature of the part is seldom elevated; deformity results from destruction of bone, cartilage, and ligament, from muscular spasms, and from the habitual assumption of certain attitudes to secure relief from pain. There is soon impairment of joint-motions. When the products of a tuberculous arthritis caseate, the thick liquid seeks exit by forming sinuses from which caseous pus flows. If a sinus becomes infected with pyogenic cocci, and the joint itself becomes their prey, acute suppuration arises in the joint, and constitutional involvement is pronounced and perilous to

In pannous synovitis a large effusion is formed, there is but little granulation tissue, though the tubercles are present in large numbers, and the ligaments and structures about the joint are slightly or not at all implicated.

Diagnosis and Prognosis.—Tuberculous chronic synovitis produces great swelling and distinct thickening of the capsule with obliteration of the outlines of the joint, but there are no spasm, no atrophy, no limitation of motion, no severe pain, and no tendency to subluxation (Shaffer). Tuberculous arthritis rarely causes distinct fluctuation, does not thicken the capsule, causes reflex muscular spasm, rigidity of the joint, muscular atrophy, severe pain on movement, and eventually subluxation (Shaffer). In syphilitic arthritis there is usually some fluctuation, distinct enlargement of the joint, limitation of motion, no reflex spasm, trivial atrophy, but distinct pain on motion (James K. Young, "Therapeutic Gazette," June 15, 1902). Acute rheumatism attacks more than one joint, is very rare in childhood, and produces high fever. The x-rays aid in the diagnosis of tuberculous arthritis and enable us to tell the extent of bone-involvement.

The diagnosis in a tuberculous joint is often difficult, and sometimes impossible, and the prognosis is always grave. In only a very few cases, even when recognized early, is a cure obtained without some impairment of joint-function. The best that can usually be accomplished is a cure with more or less ankylosis, fibrous or bony; and often ankylosis is complete. Long after the disease is apparently cured, it may break forth anew. Tuberculous

lesions may arise in a distant organ, or general tuberculosis may occur. Caseation is apt to produce severe constitutional disorder. Infection by pus-organisms gives rise to grave danger of septicemia. Death is not unusual from exhaustion, from septicemia, from disseminated tuberculosis, from

tuberculosis of an important organ, or from amyloid disease.

Treatment.—Conservative treatment is especially successful in children. According to Hoffa, in 75 per cent. of cases in children non-operative treatment will produce cure ("Die Bekampfung der Knochen- u. Gelenktuberculose in Kindesalter Tuberculosis," iv, 1, 1905). This conservative treatment consists in open-air life, if possible in a sanitarium, the following of the plans outlined under Tuberculosis, immobilization and extension of the joint, and injections of iodoform emulsion. Even when tuberculous pus forms the same treatment may be followed unless there is violent pain or elevated temperature which does not quickly abate, in which case operation must be performed. Cases treated early by conservative methods may get well with a movable joint, but in most cases there is a stiff joint when the disease is arrested. Constitutionally, the treatment is directed against the tuberculous diathesis. The patient should be placed under good hygienic conditions. A change of climate is often of the greatest importance. Many cases do well at the seaside; others require high altitudes, and all should live in the open air. Locally, rest is of the first importance, and fixation is maintained for many weeks. Rest is best secured by immobilization and traction, and traction is applied or maintained by splints, by plaster-of-Paris bandages, or by extension appliances. The hot-air apparatus may be of some benefit. If it is employed, it should be used daily, the limb being immobilized during the remainder of the twentyfour hours. Fixation must be maintained as long as pain exists or can be induced by movement or pressure. Fixation must be abandoned gradually, and mobility is to be slowly regained. During restoration to mobility, if pain arises, the part must be again, but temporarily, immobilized. Movements should never be violent, prolonged, or repeated at too close intervals. Forcible breaking up of an ankylosis is never advisable in the knee, ankle, or hip; it is seldom advisable in the arm. Such an attempt may be followed by a fresh outbreak of the disease. Osteotomy or resection will more safely correct a faulty and disabling deformity. In tuberculous joints intra-articular injections of iodoform are often of the greatest value. This drug strongly stimulates the formation of fibrous tissue. If sufficient fibrous tissue is formed the tuberculous foci will be firmly encapsuled and the case will be cured. plan of inducing passive hyperemia is often of great service (page 116). Aspiration or incision can be used for fluid accumulations. Caseous masses are often let alone, or an aspirator is used and the joint drained, washed out with saline solution, and injected with an emulsion of iodoform and glycerin (10 per cent.). From 1 to 2 drams are injected into the joint of a child, from 2 to 5 drams into the joint of an adult. Even surface lesions are not curetted. Bier's treatment should be associated with immobilization and systemic treatment. It is more serviceable in tuberculosis of the small joints than in disease of the large articulations. There are certain contra-indications to Bier's treatment, viz.: serious pulmonary involvement, extensive amyloid degeneration, and the existence of such an unfavorable position of the parts that cure by ankylosis would mean a less useful limb than cure by resection (Bier at

Internat. Surg. Congress of 1905). One advantage of this treatment is that we can employ active and passive motion early, except, according to Bier, when the foot or knee is diseased. In many very serious cases cure is obtained without any limitation of activity and, as the patient can get about, it is not necessary to restrain him long in a hospital. Personally I believe that fixation should be the basis of treatment in most cases and that passive hyperemia, compression, counter-irritation, and iodoform injections should be additions to fixation. Injections of balsam of Peru or of iodoform emulsion about the joint once a week are efficient in some cases. It is not wise to attempt to correct faulty position until the focus is well.

Fistulæ are treated by the method of Beck, of Chicago, that is, by the injection of a paste containing bismuth. In early cases a bismuth-vaselin paste

is used, in late cases a bismuth-wax-paraffin paste.

Beck described his method in the "Illinois Med. Jour.," April, 1908. The vaselin paste is composed of 30 parts of subnitrate of bismuth and 60 parts of vaselin, mixed while boiling. The paste for later cases is composed of 30 parts of subnitrate of bismuth, 5 parts of white wax, 5 parts of soft paraffin, and 60 parts of vaselin, mixed while boiling. One per cent. formalin is often added to these pastes. The paste is injected before an x-ray picture is talken, and the picture shows all the ramifications of the fistula. The paste is left in for treatment. If a sequestrum exists it should be removed before the paste is injected. It is not necessary, but is advisable, to dry the fistula before injecting.

The paste is sterilized before using. It is sucked up into the syringe while still liquid and is cooled to the requisite temperature and hardened to the proper consistency by running cold water over the syringe. It is injected very slowly and the injection is continued until a sense of pressure annoys the patient. Then the syringe is laid aside, a bit of gauze is held for a time over the outlet of the fistula to keep the paste from running out, and an ice-bag is put over the region to quickly harden the injected material. There is no pain from such an injection. Beck employs the first paste until pus disappears and

The value of this paste is that it distends and fills the abscess-cavity and sinus, and affords a trestle or frame for granulations to grow upon. Considerable of the paste may run out of the fistula during the first twenty-four hours. In shallow sinuses it all runs out. In deep and tortuous fistulæ much of it remains for weeks and is slowly absorbed. In empyema and bone cavities it is slowly absorbed. Beck holds that the paste is bactericidal, astringent, and non-toxic. Cases of ulceration in the mouth from absorption of bismuth have been recorded and at least one death is on record (Eggenberger, in "Zentrally latt für Chir.," Oct. 31, 1908). Beck limits the first dose to 100 gm., but increases the amount later. This is undoubtedly a valuable method. I have seen sinuses heal under it after they had resisted various other plans of treatment. It may be used in sinuses, cold abscesses, empyema, tuberculous joints, and other conditions.

If these means fail, if the patient gets worse, if there is persistent fever or violent pain, if sequestra exist, if there is mixed infection, or if the condition of the sufferer renders dangerous the prolonged conservative course, operate, removing the entire diseased area by erasion, by excision, or possi-

bly by amputation. If the x-ray picture shows extensive sequestrum formation, operation is indicated. If amyloid degeneration exists, conservative treatment is contraindicated and so is resection. Amputation must be done. Always remember that an incomplete operation or a partial removal, unless it consists of simple drainage, is worse than no operation, as it opens the portals to systemic infection, and may be responsible for the development of general tuberculosis, septicemia, or pyemia. Simple drainage, as previously stated, is seldom advisable. Garre is of the opinion that the hip, wrist, and shoulder do best by conservative treatment; the knee, elbow, and ankle by operative treatment (John W. Churchman, in "Am. Medicine," April, 1906).

Tuberculosis of Special Joints.—Tuberculosis of the Sacroiliac Joint (Sacro-iliac Disease).—This is an uncommon affection, and is especially rare before the age of fifteen. The disease may begin in the joint, may arise in adjacent bones, or may result from a cold abscess burrowing into the joint. In some cases it is associated with extensive disease of the pelvic bones. The disease, if undetected, may lead to dissemination of

tubercle, to abscess, or even to death.

Symptoms are often obscure. The disease is frequently confounded with vertebral caries, hip-joint disease, or sciatica. The patient limps on walking,



Fig. 334. -Sacro-iliac disease; operated upon and cured.

but can stand on either leg; there is pain in the sacro-iliac joint, about the hip, and down the thigh; tenderness is manifest on pressure over the joint and on pushing the ilia together; there is fulness over the sacro-iliac joint; but the hip is not flexed unless iliac abscess exists.\*

Treatment.—Rest in bed for months, using also a felt case for the pelvis. Counter-irritation by blisters and the actual cautery. In some cases injection of iodoform; in others, incision and curetting. I have operated on six cases, with one death. In one case in the Jefferson Medical College Hospital the

<sup>\*</sup> See A. G. Miller, Edinburgh Med. Jour., May, 1895.

abscess was pointing in both the back and groin. Both areas were incised, the diseased bone was removed, and the boy ultimately recovered (Fig. 334). In a pother case the abscess pointed in the groin. The treatment was as pre-

vious ly set forth, and the patient, a woman, recovered.

Duberculosis of the Hip-joint (Hip Disease; Morbus Coxarius; Morbus Coxa; Coxitis; Hip-joint Disease).—The primary lesion may be in the sync vial membrane, but it is more often in the bone. It may begin in the aceta bulum; it may begin in the femur. In 95 per cent. of cases it begins in the head of the femur. If it begins in the femur, it usually arises on "the distal side of the epiphyseal cartilage" (Senn). Sometimes primary tuberculosis arises in the trochanter major, and never involves the joint. When the synovial membrane becomes involved at any point, spreading throughout the joint is rapid. In many cases the articular cartilages are attacked, and in some cases the epiphyseal cartilage is destroyed. It is commonest in children, but it may arise in adults and even occasionally in those of advanced years; 62 per cent. of cases arise in children under ten years of age and 80 per cent. of cases occur before the twentieth year (Bryant). Traumatism and cold may be predisposing causes. The disease strongly tends to caseation and the formation of sequestra.

Symptoms.—It has been usual to divide the disease into three stages: (1) the stage of microbic deposition and multiplication, the products of the bacilli causing irritation and new growth; (2) the stage of progression, with formation of masses of granulation tissue and effusion into the joint; and (3) the stage of caseation, with destruction of the joint and often of the structures about it. Bradford and Lovett\* protest against this. They say: "It has been customary to divide hip-disease into stages, and to ascribe to these stages certain definite symptoms. Neither from a clinical nor a pathological point of view is it desirable to attempt such a division." As H. Augustus Wilson says: "Tuberculous bone and joint disease should be considered as the primary invasion or incipiency, and all other symptoms should be regarded as results and not as an integral and necessary part of the trouble."

The symptoms of incipient coxalgia are slight and may be overlooked entirely. In a child there are night-terrors; on getting about in the morning the child shows no lameness, but a limp develops during the day, and the little one soon grows tired while playing and lies down to rest. There is a slight limp; some adductor spasm is noted, and pain may be complained of at night in the hip, in the front of the thigh, or at the inside of the knee. Tapping the sole of the foot, the thigh and leg being extended, may develop pain, just as it will develop pain in any inflammatory involvement of the joint. But the employment of this method is objectionable. It may injure a joint already darnaged by the tuberculous process, and it gives no information which cannot be obtained by a safer mode of investigation. After all, pain on tapping the sole of the foot means only what muscular rigidity means, and muscular rigidity is always present and is easily demonstrable by careful manipulation. The diagnosis in this stage is more or less problematical.

As the disease progresses more positive symptoms are observed. The limp grows worse; the adductor muscles become rigid; the hip is broadened by an effusion into the joint, and fluctuation may possibly be detected; the thigh-

<sup>\*</sup> Orthopedic Surgery.

muscles atrophy; the extremity is pushed forward, abducted, and everted (the patient tilts the pelvis so as to rest his weight on the sound limb). In some few cases adduction exists rather than abduction. The abduction, which is usual, releases tension of the fascia lata, and thus abolishes pressure upon the joint through lessening of pressure upon the great trochanter (Allis). The thigh is somewhat flexed. This flexion relaxes the psoas muscle and prevents pressure of its tendon upon the front of the joint (Allis). exists, often sudden or starting, and is located in the joint, on the front of the thigh, and to the inner side of the knee in the course of the obturator nerve; the pain is aggravated at night; and full extension and complete abduction are not possible. The gluteal muscles waste, and the gluteal crease is on a lower level than is that of the sound side. The gluteal crease may be nearly or quite effaced, because of hypertrophy of the subcutaneous layer (Alexandroff). Jarring of the heel when the extremity is in extension causes pain in the hip. The above symptoms arise chiefly from unconscious efforts to obtain ease, from joint-effusion, reflex irritation, and involuntary or spasmodic muscular contractions. There is an appearance of lengthening, or shortening, but it is only apparent, not real. The real position is shown on Plate 7, Fig. 4. The fluid effusion may be absorbed or may find its way

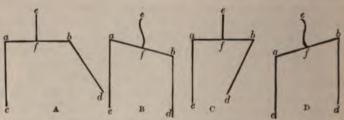


Fig. 335.—Positions in hip-joint disease (after the plan of Howard Marsh and Treves): A = ef, lumbar spine; b d, limb fixed in flexion and abduction—useless for walking. B = ef, lumbar spine. Patient corrects the condition in Figure A by curving the lumbar spine forward and rotating the pelvis on its transverse axis, thus making the femur point downward. The lumbar spine is curved laterally, the pelvis ascending on the sound side and descending on the affected side (apparent lengthening). C = b d, limb fixed in flexion and adduction. D = ef, curve of lumbar spine to correct condition in Figure c (apparent shortening).

externally by means of sinuses. The latter condition is known as "abscess of the hip." The absorption of the exudate or the rupture of the capsule permits the contracting muscles to bring the head of the femur into firm contact with the acetabulum or its brim; the bones are worn away and destroyed, shortening results, abduction gives way to adduction, and flexion is increased, as shortening occurs.

In advanced cases of coxalgia the head of the femur passes upward and outward upon the rim of the acetabulum, the thigh is flexed and fixed, and attempts at extension when the patient is recumbent cause the pelvis to tilt forward and occasion a marked lumbar curve (lordosis) (Pl. 7, Fig. 2), which is due to the pelvis moving with the femur as if ankylosed, and which disappears on flexion. In this condition adduction occurs because of the ascent and movement outward of the head of the bone. Shortening is marked. After a hipabscess finds an external outlet pyogenic infection is very apt to take place

and suppuration arises, which is followed by that state which is designated as "hectic." If a cure follows advanced coxalgia, partial or complete ankylosis takes place; if death ensues, it may be due to septicemia, tuberculosis of the viscera, exhaustion, or amyloid degeneration.

Diagnosis is very easy in well-established cases of hip-disease, but very difficult when the disease is incipient. Always make a systematic and thorough examination. Undress the patient and place him recumbent with his legs extended upon a table or a hard mattress. Note if the heels are level and if the iliac spines are on the same level (a depressed spine on the affected side means abducted extremity, the degree of which is determined by carrying the limb out until the spines are horizontal; elevation of the iliac spine on the affected side means adduction, the amount of which is determined by adducting the limb until the spines are horizontal; Fig. 335). Try all the movements be longing to the joint, to detect any limitations; observe if bringing down the knee produces lordosis; look for swelling and for muscular wasting; feel if the head of the bone is enlarged; determine if motion produces pain or if pressure develops tenderness; and always carefully elicit the history of the attack, of the person, and of the family.

Hip disease may be confounded with spinal caries in which a psoas or a lumbar abscess has formed, with sacro-iliac disease, with infantile paralysis, with congenital dislocation of hip, with lordosis from rickets, with gluteal abscess, and with bursitis of the gluteal bursæ. In hip disease there is always some lameness; pain may be severe, may be trivial, or may be absent entirely, and may be in the hip or be referred to the front of the thigh or the inner side of the knee. Always remember that the pain is not characteristic, and that pain in the same localities may arise from aneurysm of the femoral or iliac arteries, from abscess in Scarpa's triangle, from caries of the lumbar vertebræ, from sacro-iliac disease, and from cancer of the rectum. Altered position of the limb, limitation of movement in the hip-joint, muscular wasting, and swelling seon arise in hip-joint disease.

In disease of the sacro-iliac joint examination shows that the movements of the hip-joint are unlimited and produce no pain, and that pain is developed by pressure over the sacro-iliac articulation and by pressing the ilia together. In infantile paralysis there is no pain, but there is paralysis with great muscular at phy, which comes on with considerable rapidity. In spinal caries with pso as abscess the evidences of disease of the vertebræ are clear and a collection of uid is located in the groin external to the femoral vessels. The tuberculous pus of hip-abscess generally gathers under the tensor vaginæ femoris muscle, but it may reach Scarpa's triangle by passing through the cotyloid notch or through the bursa under the psoas muscle; it may even appear under the glutei. Matter from a caseating acetabulum may reach the interior of the pelvis and appear above Poupart's ligament.

In gluteal bursitis the symptoms last for many months, and do not remit as the symptoms of early hip disease are apt to do. The pain is but moderate, and is aggravated by exercise, but passes away on going to bed, and is felt back of the hip and back of the knee. There are a certain amount of limitation of motion and a positive limp, which arises early. In marked cases fluctuation be detected in the upper gluteal region.\*

See E. G. Brackett's important paper on "Gluteal Bursitis" in the Transactions of the American Orthopedic Association, vol. x.

Prognosis.—If the case of hip disease is seen early, the chances of cure are excellent in children, in whom the disease may be arrested at any stage. The longer the duration of the disease and the older the subject, the more unfavorable is the prognosis. Many months will be required to elapse before a cure can be effected, and advanced cases only get well by means of ankylosis with shortening and deformity. Hip disease may recur years after apparent cure, and a person who has or has had hip disease runs a strong chance of developing visceral tuberculosis.

Complications.—The complications that may accompany hip disease are the following: Abscess, as above noted. Tuberculous meningitis, or the condition known as "acute hydrocephalus" or "water on the brain," may arise during the progress of the case or after apparent cure, and is apt to ensue upon incomplete operations. It is almost inevitably fatal. Phthisis pulmonalis is a rare complication, but is a common sequence, being apt to arise, sooner or later, after the hip disease is cured. Amyloid, lardaceous, or waxy degeneration of viscera follows upon profuse and long-continued suppurations and is apt to arise in the liver, spleen, kidneys, or intestinal mucous membrane. Tuberculosis is not the only cause of amyloid degeneration, syphilis being responsi-



Fig. 336.—Thomas' posterior splint.

ble for at least 30 per cent. of all cases. In amyloid disease of the liver this organ is much enlarged, smooth, painless, and of increased consistency; there is no jaundice, the spleen is apt to be enlarged, and albuminuria is the rule. In amyloid kidney large amounts of pale urine of low specific gravity are voided; albumin is usually present in large amount, but may be absent; globulin may often be found, as may also hyaline, fatty, or granular casts; the patient is anemic, and dropsy usually exists. Test the hyaline casts with iodin for amyloid material. Amyloid changes are usually slow in onset; but they may be rapid; they are commoner in men than in women, and are most frequently encountered in individuals between the ages of ten and thirty. Slight amyloid change may be recovered from, but an extensive degeneration brings about a fatal result. Dickinson's theory of how this tissue-change is caused is that the flow of pus drains off from the body the alkaline salts, especially the salts of potassium,

which drainage results in visceral depositions of dealkalinized fibrin.

Treatment.—In most of these cases conservative treatment is advisable. Antituberculous treatment is used in all cases. In incipient hip disease the treatment usually advocated is rest. The patient is placed upon a solid mattress and extension is applied. In children under ten years of age a weight of from three to five pounds is used; in individuals between ten and twenty a weight of from five to eight pounds is used. A long splint is often applied to the sound side to keep the patient recumbent and horizontal. A cradle is employed to hold up the bed-clothing. The extension is applied in the long axis of the limb, the extremity being placed in the line of the deformity due to disease and being properly supported. In lordosis from thigh-flexion the limb

is raised until the iliac spine is straight (Pl. 7, Fig. 5). If the spine is depressed on the affected side, the limb is abducted (Pl. 7, Fig. 6); if the spine is elevated, the limb is adducted until the spines are horizontal (Pl. 7, Fig. 7). The object of extension is to overcome muscular spasm and so put the part in a condition of physiological rest. Muscular spasm is a great factor in destroying structures. Spasm presses the parts together, and as a result of pressure plus bacterial action destruction occurs. The extension and traction tire out the muscles and cause spasm to cease. Extension will remove flexion in two weeks in a recent case and in the course of some months in an older case. As flexion is relieved the pillows are removed and the leg lowered, but extension is maintained in the



Fig. 337.—Sayre's long splint.



Fig. 338.—Wyeth's combination method.

long axis of the thigh. Abduction and adduction cannot be removed by simple extension in the axis of the limb.

Abduction demands no special treatment. In a movable joint it will disappear, and in an ankylosed joint it is an advantage, compensating by apparent lengthening for the shortening due to bone-absorption or to stunned growth of the limb. Adduction requires an addition of several pounds to the extension weight, the use of a long splint on the sound limb, and the drawing up of the sound side by a rope and pulley toward the head of the bed. The weight used to pull the sound side toward the head of the bed is equal to that used to pull the damaged side to the foot of the bed. This expedient is used for a month or six weeks. In old cases where the weight will not bring about extension, the patient is anesthetized, the limb is gently straightened a verifitile, and the weight is reapplied.

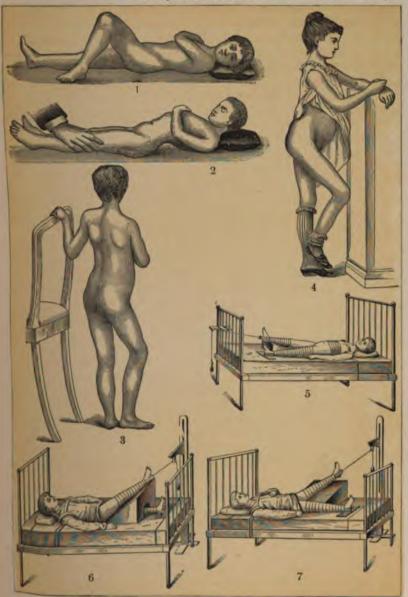
Extension in a mild case must be continued for three months after the symptoms have disappeared, and in a severe case the period must be six months. The weight is gradually taken off; if symptoms recur, the weight is reapplied; if they do not recur, apply a traction splint or a plaster dressing, put a high-heeled boot on the sound limb, and send the patient out on crutches. In young children extension can be made while the child is in a wheeled carriage, thus enabling the patient to go out in the fresh air and sunlight. The general treatment is tonic and restorative. The joint is so deeply placed that external applications are useless. In the treatment of hip disease Thomas' splint (Fig. 336) is used by many, and it may be combined with weight extension; or Sayre's splint (Fig. 337) may be employed. Wyeth's apparatus (Fig. 338) is a favorite with many American surgeons.

If the limb is in good position, or has been brought into good position, either by weight extension or straightening under ether, plaster of Paris is a useful dressing. It is applied from the toes up, and includes the entire extremity and also the pelvis. A patient wearing plaster may get about on crutches when the sole of the foot of the sound extremity is raised by the wearing of a thick-

soled shoe.

Treatment by Weight-bearing and Fixation by Hip Spica of Plaster of Paris (Lorenz's Method).—This plan is, in most cases, vastly preferable to extension in bed. To keep the patient in bed is to keep him from the open air and sunlight, which are so necessary in tuberculosis. Such confinement favors muscular atrophy, leads to anemia, and lessens vital resistance. The hip is placed in 20 degrees of flexion, 20 degrees of abduction, and 5 degrees of external rotation, and is fixed by a short plaster spica of the hip. The patient walks and so antagonises muscular spasm. The joint surfaces bear weight, which leads to a useful increase of blood supply (curative hyperemia), but do not grind upon each other, hence, the spread of the disease is not favored. That muscles increase in size is shown by the fact that the cast gets tight and must be changed from time to time. The open-air life and exercise are of the greatest benefit to the patient and a gain in weight is the rule. Cases in a debilitated condition or those with discharging sinuses must not be treated by this plan "without the temporary use of crutches" (H. A. Wilson, in "Southern Med. Jour.," Dec., 1908). Incipient cases are most suitable for treatment by this plan. The average duration of treatment is about ten months (H. A. Wilson, Ibid.).

Intra-articular Injections and Operation.—If in spite of treatment the condition does not improve or if it becomes worse, use intra-articular injections of iodoform or of bismuth paste. Always try these injections before doing a resection unless the x-rays show a large sequestrum. Sometimes they succeed, and if they do, resection is unnecessary. Asepticize the surface, carry a small aspirating needle into the joint, irrigate the joint with salt solution, and inject a sterile emulsion of iodoform and glyceria (10 per cent.). In one week, if reaction has ceased, repeat the injection. In another week repeat it again. It may be necessary to give from ten to twenty injections. The proper spot for puncture is thus determined. Draw a line from a point half an inch outside of the middle of Poupart's ligament to the outer edge of the great trochanter. Puncture at the middle of the outer half of this line (De Vos). I have not attempted to remove the disease sur-



1, 2. Effects on the Lumbar Spine of Flexing and Extending the Diseased Leg in Hip Disease (Alben). 3, 4. Positions in Coxalgia (Albert). 5. Extension in Hip Disease (Treves). 6. Extension of the Limb in a Flexed and Adducted Position (Treves). 7. Extension of the Limb in a Flexed and Adducted Position (Treves).

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gically early in any case and greatly doubt the wisdom of doing so. Huntington and some other surgeons advocate early operation in children instead of simply fixation, extension, and rest. Huntington ("Am. Jour. Med. Sciences," July, 1905) recalls that when the lesion is in the head of the femur, it tends to perforate into the joint and he advises trephining at the lower border and outer aspect of the great trochanter and tunnelling the neck and head of the femur with a curette. Bradford objects to this method in most cases on the ground that unless the disease is localized and the cavity is well walled off and unless injury to the localizing barrier is avoided, the operation may be responsible for dissemination of the bacteria.

If an abscess forms, incise it with the most thorough antiseptic care, let the fluid drain away, irrigate the cavity with salt solution, remove any sequestra, inject with iodoform emulsion, sew up without drainage, and dress antiseptically. In some cases the sequestrum is extra-articular. In many cases no sequestrum is found. If this method fails, drainage must be employed. The old plan of not operating until rupture was seen to be inevitable was wrong. To open early and antiseptically often means rapid healing, the prevention of burrowing, a lessened danger of visceral infection, and an earlier cure. In contrast to what happens when a very large cold abscess is opened hectic will rarely arise when a tuberculous joint is opened with antiseptic care.

Excision of the hip is to be performed when there is a large sequestrum or severe fistulæ (Garre, "Deutsch. med. Woch.," 1905, Nos. 47 and 48); when the head of the femur is detached and lies loose in the joint; when profuse suppuration continues for a long time, and other methods fail to arrest it; when amyloid disease is threatening; or when very faulty position is inevitable without operation. Excision is an operation of considerable danger, and the older the person, the greater the danger. Schede advocates arthrectomy in some cases as a substitute for resection. Senn tells us that opinion as to resection has greatly changed of late, and it is now taught that the operation is advisable in all cases where fixation, extension, intra-articular and parenchymatous injections have failed to arrest the disease (Senn on "Tuberculosis of Bones and Joints"). Resection of the hip does not give a very satisfactory functional result. When there is extensive disease of the femur, when excision has been tried and has failed, when the patient has not the recuperative power to withstand the long siege of illness following excision, or when there is amyloid disease, amputate.\* Amputation of the hip joint for tuberculous disease is a very successful procedure.

Knee-joint Disease (White Swelling).—After the hip, the knee is, of all the commonest site for tuberculous disease. Knee-joint disease can as a synovitis, but oftener begins as tuberculous inflammation of the oral or the tibial epiphysis. Tuberculous disease rarely attacks the bone the diaphyseal side of the epiphyseal line; a single focus only exists, as a and a sequestrum is rarely formed. In very rare instances the patella or the semilunar cartilage is primarily attacked. It may begin at any age, but is most common in children and young adults. If an acute synovitis ushers in the case, there may be a large effusion into the knee-joint and partial flexion, but swelling is usually slight in knee-joint disease. Pulpy degentration of the synovial membrane occurs; the joint enlarges; the ligaments

See the admirable article of Howard Marsh in Treves's "Manual of Surgery."

soften; the skin becomes edematous, and muscular spasm arises. The leg becomes flexed; the bones displaced backward and outward; the foot everted; and lameness arises, due chiefly to deformity. Pain may be absent, is often slight, and is rarely severe. When the disease begins in the bone or



Fig. 339.-Sayre's knee splint applied.

Fig. 340.-Hutchknee-joint

an epiphysis there are pain, tenderness, lameness, swelling, inability to extend the limb completely, sudden spasmodic muscular contractions, and final involvement of the joint. When an abscess forms, it may destroy the joint very rapidly or it

may break externally.

Treatment. - In treating knee-joint disease conservative treatment is usually tried but often fails. A plan of doubtful value is to make a mixture of guaiacol and tincture of iodin or guaiacol and olive oil (1:4). Once a day the surface of the knee is exposed by removing dressings, is painted with this mixture, and the painted surface is covered with cotton-wool. Rest is of the first importance, and may be secured by the application of splints (Figs. 330, 340), the use of extension (Fig. 341), or the employ-

ment of a plaster-of-Paris bandage. In any case the patient must be kept in bed for a few weeks; he may then be permitted to go out upon crutches, wearing a high-heeled shoe upon the foot of the sound limb. In cases in which treatment is begun early the disease may often be arrested in from eight to twelve months. If the symptoms do not abate after a number of weeks, or if the condition grows worse and caseation occurs, aspirate, irrigate, and inject iodoform emulsion or bismuth paste. Intra-articular injections are not unusually curative. Insert the needle in the angle between the outer edge of the patella and the ligament of the patella (De Vos). Repeat the injection in one week if reaction has abated, and continue as directed for the injection of the hip-joint. If this plan fails, incise the capsule, remove all fragments and tuberculous foci, irrigate with normal salt solution, inject iodoform emulsion, and sew up without drainage (Neuber's plan). A more severe case requires drainage. If these means fail, or if the case is too far advanced to permit of their use, open the joint and perform an excision or an erasion (page 700). Excision gives a satisfactory result in most cases, although it leaves a stiff knee and marked shortening. Garrè considers any shortening over 5 cm. a bad result, and he got such a bad result in 7.5 per cent. of his 117 cases. In children shortening follows even conservative treatment, and the shortening which follows excision is due in part to removal of bone and in part to impairment of the nutritive power of the epiphyseal cartilage. Some cases demand amputation, which, if the patient's health is much impaired or if amyloid disease exists, is to be preferred to excision. Amputation is preferred to excision in very young children and aged people.

Ankle-joint disease may begin in the synovial membrane, in the tibial epiphysis, or in the tarsus, but the origin is usually synovial. The symptoms

are pain, swelling, lameness, limitation of joint-movements, and atrophy of the calf-muscles. Caseation often occurs and sinuses form.

Treatment.—Conservative treatment with iodoform injections will cure many cases. Rest is obtained by means of splints or plaster-of-Paris bandages. Caution the patient to avoid standing upon the diseased extremity. In making an intra-articular injection insert the needle below the outer malleolus. When caseation occurs, it is advisable to open the joint, wash out with normal salt solution, inject iodoform emulsion, sew up the incision, and put up

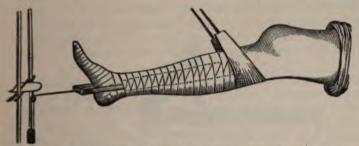


Fig. 341. -Sayre's double extension of the knee-joint.

the ankle-joint in plaster. When there is considerable bone disease, when fistulæ exist, when adjacent joints or tendons are diseased, or when joint-disorganization occurs, perform an excision or an erasion. Some cases demand amputation (Syme's amputation being preferred by some, amputation above the ankle being approved by many). Osteoplastic resection is sometimes advised (Wladimiroff-Mikulicz operation). Operative treatment is more satisfactory in children than in adults (Garrè).

Shoulder-joint disease is not common; it is rare in children and is commonest in adults; it may begin in the synovial membrane, but usually begins in the head of the humerus. The glenoid cavity is rarely attacked. Pain is slight, atrophy of the deltoid and other muscles is noted, the joint is stiff, and the scapula follows the motions of the humerus. Caries sicca is the usual cause of destruction. In many cases swelling is not obvious, the joint shrinking because of destruction of the head of the bone and contraction of the capsule (Senn). Abscess-formation is unusual. If an abscess forms, it may open in the axilla, through the deltoid muscle, or at some far distant point. It is frequently complicated by pulmonary tuberculosis.

Treatment.—A majority of cases recover from conservative treatment, a stiff joint resulting. Put on a shoulder-cap, apply the second roller of Desault, and hang the hand in a sling. Maintain rest for at least four months. Aspiration and injection of iodoform emulsion or of bismuth paste are of great service in synovial tuberculosis. In making an intra-articular injection the needle is entered below the acromion, while the arm is held against the side and the forearm is at right angles to the arm and across the front of the chest (De Vos). If caseation occurs, open the joint, temove tuberculous foci, wash with hot saline fluid, inject iodoform emulsion, and close without drainage, or, in a rather severe case, drain. In rare instances dead bone will have to be gouged away. Caries sicca may occur Excision is sometimes required, but the results are seldom satisfactory.

Elbow-joint disease may begin in the humerus or the ulna. The head of the radius is rarely the primary focus. In some cases the synovial membrane is first attacked. The disease is most frequent in young adults. The joint is swollen, its movements are somewhat limited, muscular wasting is pronounced, and pain is generally slight. Tuberculous pus may form.

Treatment.—In treating early elbow-joint disease, especially in young children, conservative treatment is very successful. Rest is secured by means of an anterior angular splint (Fig. 342) and a triangular sling or a plaster-of-Paris dressing. Splints are to be worn for from four months to a year. Injec-

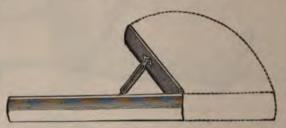


Fig. 342.-Stromeyer's anterior angular splint.

tions of iodoform emulsion are usually employed. Insert the needle for injection by the side of the olecranon. In a cure by conservative methods a stiff joint will result. It may be necessary to perform resection because of extensive bone disease. Resection gives an excellent functional result.

Wrist-joint disease may arise at any age, and is sometimes met with in late middle life or even in old age. The joint presents a puffy swelling, loses its normal contour, and becomes spindle-shaped. Hand-movements are impaired, pronation and supination cannot completely or satisfactorily be performed, the joint is stiff and partly flexed, the grasp is enfeebled, pain may be severe or slight, the skin is sometimes but seldom hot, and muscular atrophy is marked. This form of tuberculosis may begin in the synovial membrane, in the bones, or in the tendon-sheaths.

Treatment is usually conservative and very successful, giving, as a rule, a functionally useful joint and movable fingers. Garrè recommends a trial of the method even when there are fistulæ and when there is necrosis of the carpus. Apply a Bond splint and sling or put on a plaster-of-Paris bandage and maintain strict rest for from four to six months. Aspiration and injection of iodoform emulsion or bismuth paste are used. Enter the needle at the dorsal edge of the radial styloid process, and again at the upper edge of the pisiform bone (DeVos). In some cases it is well to incise, wash with salt solution, inject iodoform emulsion, and close without drainage. Severe cases demand incision and drainage with the maintenance of rest. Resection is to be avoided if possible. It gives a bad functional result, the amount of bone removed leaving the tendons too long and contractions of muscle being common (Garrè). It may be demanded because of extensive caries or sequestra formation. Amputation is occasionally necessary.

Non-tuberculous Arthritis.—Most of these cases, acute and chronic, are of infectious origin. Some of them are non-infectious. Among the non-in-

fective forms the joint lesions of locomotor ataxia and syringomyelia—constitutional conditions, as gout, purpura, hemophilia, and scurvy—functional derangements expressed by articular neuralgia or intermitting hydrops and traumatic states (see Hoffa, in "Zentralbl. f. Chir.," 1907, xxxiv; and Bloodgood, in "Progressive Medicine," Dec. 1, 1907).

Traumatic Arthritis.—This may be due to a single injury (a sprain or a bruise) or to some continuing cause (genu valgum may cause arthritis of the

knee; flat-foot may be responsible for arthritis of the knee or hip).

If a contusion or sprain causes relaxation of the capsule or fixing tendons, the joint becomes loose and injures itself again and again during movement. It does the same thing when there are loose bodies or enlarged synovial finges. Traumatic arthritis usually involves but one joint. A recent traumatic arthritis is treated by protecting the joint, massage, hot air, and passive motions.

If a continuing cause is present it is to be removed. Distant causes may be removed by orthopedic apparatus or by operation. Causes within the joint may be sought for by arthrotomy and when found they should be removed. For instance, in the knee, inflamed synovial fringes may be responsible for chronic inflammation. They get caught between the joint surfaces, are squeezed, and trip the victim. They should be removed. Lockwood ("Brit. Med. Jour.," July 3, 1909) points out that an overgrowth of fat may get between the tibia and femur and be squeezed. This surgeon calls attention to the fact that there are "adipose pads immediately above the articular surface of the femur, and on either side of the upper end of the patella" (Ibid.). He calls them the pads of Malgaigne, after the French surgeon who described them in 1859. If they are subject to repeated traumatism they should be removed.

Infective Arthritis.—In this condition the inflammation is due to bacteria. In some cases pus forms and pyogenic bacteria are demonstrable in fluid removed by aspiration. In other cases, perhaps exhibiting as acute symptoms, no pus forms and no bacteria are demonstrable in the fluid removed by aspiration. The latter cases are due to toxins or to bacteria of attenuated virulence. Secondary infection may occur. In wounds and in most cases the disease is polyarticular, but if osteomyelitis is the cause it may be monarticular. The bacteria may reach a joint by way of a wound, from an adjacent focus of osteomyelitis, from a near or distant area of infection, from the genito-urinary tract, or by way of the tonsils. Organisms not directly introduced into the joint reach it by way of the blood or lymph.

The disease may arise during the course of gonorrhea or any infectious process. It may arise when no area of infection can be discovered. It may arise in the course of an acute infectious disease (such as erysipelas, typhoid fever, pneumonia, influenza, mumps, dysentery, diphtheria, measles, scarlatina, variola), and may be due to pyogenic cocci, to the specific micro-organism of the acute infectious disease, or purely to microbic products. Joint inflammation arising in the course or as a sequel of an acute infectious disease may

or may not suppurate.

Symptoms.—If no suppuration takes place, the symptoms of the attack resemble those of rheumatism; if suppuration occurs, the symptoms are the same as those of acute suppurative arthritis, with which disease this form of

infective arthritis is identical. Suppuration rarely occurs. Ashby has well described the arthritis which sometimes follows scarlatina. It involves the wrists, finger-joints, tendons of the forearms, the knees, ankles, or spine. The joints are painful, but are rarely much swollen or discolored (Howard Marsh). We can distinguish infective arthritis from rheumatism by the fact that it does not migrate and is uninfluenced by antirheumatic remedies.

Treatment.—In every case in which we suspect the condition, diagnostic aspiration is performed. If the fluid obtained contains bacteria, arthrotomy and irrigation are indicated. In all clinically severe cases and in all prolonged cases, open and irrigate, first with corrosive sublimate solution (1:1000), then with normal salt solution. Recent cases which are not very acute and are free

from pus may be closed without drainage.

Pyogenic or Acute Suppurative Arthritis.—This condition is a form of infective arthritis and is usually due to the staphylococcus pyogenes aureus or to the streptococcus pyogenes, which find entrance by means of a wound, by the spontaneous evacuation into a joint of the products of an osteomyelitis, by extension of suppurative inflammation through contiguous structures, or by the blood-stream. It is necessary to remember that causative bacteria may have entered the blood or lymph at a point near to or distant from the joint (tonsils, ethmoid cells, urethra, a focus of osteomyelitis, etc.). Of course, a wound into a joint may be the open gateway for infection. A traumatism may create a point of least resistance and bacteria may be derived from the blood or lymph. It is not very unusual for a traumatic arthritis to eventuate in a pyogenic arthritis. Particularly in youths and young children the symptoms of an arthritis may overlie and hide a causative osteomyelitis. Sometimes gonorrhea is the cause and in rare cases septicemia is causal. In pyogenic arthritis all the joint-structures are involved and suppuration rapidly appears Synovial membrane is converted into granulation tissue and cartilage is destroyed by pus. The greater the inflammation the larger the amount of granulation tissue, hence, ultimately, the greater the amount of scar tissue to repair and the greater impairment of joint function.

Symptoms.—The symptoms of acute suppurative arthritis are usually a chill followed by fever and a rapid pulse. There are severe pain, which is aggravated by motion and is worse at night; discoloration, heat, and edema of the skin; partial flexion of the joint; fluctuation; and marked constitutional symptoms of sepsis. The joint tends to rapid disorganization, and fatal septicemia is very apt to occur. In pyemic arthritis several joints become infected.

Treatment.—In every suspicious case immediately aspirate. If bacteria are found in the aspirated fluid, at once open the joint (arthrotomy) and irrigate it with corrosive sublimate solution (1: 1000) and then with salt solution. In early cases which are not very violent the wound may be closed, the limb being immobilized after the operation. In a late case or a violent case, drain by rubber tissue. Always be sure that arthritis is not the result of osteomyelitis. In conditions due to staphylococci and streptococci it often is secondary to bone suppuration. If a periosteal abscess exists the joint condition is almost certainly secondary. If osteomyelitis exists it requires prompt and radical treatment (page 503). In advanced cases involving the knee, Allen and Alden ("Surgery, Gynecology, and Obstetrics," July, 1909) open the joint by a transverse incision below the patella, disinfect with pure carbolic

acid followed by alcohol, and pack with iodoform gauze. I would only regard this as justifiable in advanced and very severe cases, as it is sure to be followed by ankylosis. Although in late cases which recover after arthrotomy and irrigation there is always more or less ankylosis, many cases treated early recover without impairment of joint function. Early arthrotomy is of the utmost importance and if the aspirated fluid contains bacteria we should never postpone operation or hold it in reserve while we employ Bier's hyperemic or any other conservative method. Radicalism is here the course which promises the greater safety, and the surest retention of joint function.

Typhoid Arthritis.-This disease is a form of infective arthritis. That the bacteria of typhoid may inflame the joints is proved, and it seems certain that they can cause suppuration, although their pyogenic power has been disputed. Some claim that mixed infection is the real cause of pus formation in a typhoid joint. The typhoid bacilli enter the bones in many typhoid cases and sometimes cause osteomyelitis. Joint-disease is more common than bonedisease. Typhoid disease of a joint begins when the fever is abating, and more than one joint may be involved. Typhoid joints may recover permaneatly, may become ankylosed, may dislocate, or the joint-disease may lead to fatal sepsis. In most cases the joints recover. In slight cases the synovial membrane only is involved; in more severe cases capsule, cartilages, ligaments, and even bones are involved. Some cases suppurate. Septic typhoid arthritis results from a mixed infection with typhoid bacilli and pyogenic bacteria, and is identical in symptoms and progress with an ordinary septic arthritis. Typhoid arthritis proper may be monarticular or polyarticular, the monarticular form being the most common, and the hip-joint being the articulation most liable to be attacked. In most cases typhoid arthritis causes but little pain. The swelling is marked, although in the hip it is concealed. Pus rarely forms. Keen calls attention to the fact that in the 84 cases he collected, spontaneous dislocation occurred in 43, nearly all in the hip.\* Fluid from a typhoid joint may be sterile (bacteria having died), may show mixed infection, or may give a pure culture of typhoid bacilli (see A. G. Ellis in "Jour. of Infectious Diseases," April 1, 1909).

Treatment.—A mild case is treated as a simple synovitis. If diagnostic puncture obtains fluid free from bacteria, no more radical method than aspiration and irrigation is required. If the fluid contains bacteria, incision

and drainage are demanded.

Gonorrheal Arthritis or Gonorrheal Rheumatism.—During the progress of gonorrhea the development of a painful joint does not of necessity prove the existence of gonorrheal rheumatism, for ordinary rheumatism is just as likely to arise when a man has clap as when he has not this malady. Furthermore, the term is inaccurate, as gonorrheal rheumatism is not rheumatism at all, but is an infective disorder of the joints or of the synovial membranes, the infective material being contained primarily in the urethral discharge. Gonorrheal rheumatism is one of the forms of infective arthritis. Occasionally this form of arthritis arises from gonorrheal ophthalmia (Heiman's case); it sometimes, though rarely, arises during the height of a gonorrhea, but it is more frequently met with in chronic cases or when the intensity of the inflammation is abating in acute cases. Men suffer

<sup>&</sup>quot;Keen on "The Surgical Complications and Sequels of Typhoid Fever."

from gonorrheal arthritis far more frequently than do women, and the seizure is very apt to recur again and again. In some cases many joints are involved, but in most cases only a few joints suffer. Osler states that the knees and ankles are most apt to be involved in gonorrheal rheumatism, and that this form of arthritis is peculiar in often attacking joints that are apt to be exempt in acute rheumatism ("the sternoclavicular, the intervertebral, the temporomaxillary, and the sacro-iliac"). There are two forms of gonorrheal rheumatism-an acute and a chronic form. The poison reaches the joint by way of the blood. In some cases gonococci are found in the joint fluid; in other cases they are not found. I am inclined to believe that in the milder cases, which recover without genuine pus-formation, only toxins are present in the joint. In the severe cases the organisms themselves exist in the articular fluid. Osler suggests that the non-suppurative cases are due to the action of toxins taken up from the area of primary infection, and that the suppurative cases are due to infection with pyogenic bacteria. Endocarditis may occur, and it is due always to micro-organisms and not to toxins.

Changes in and about the Joint.—The inflammation of gonorrheal arthritis may be located around rather than in the joint, and especially in the tendon-sheaths. Suppuration is unusual, but it may occur in joints and in tendon-sheaths. Cultivation of the exudate may or may not show the gonococci. Cover-glass preparations carefully stained may or may not show gonococci.

Symptoms.—The acute form attacks, as a rule, but a single joint, but may attack several joints. The joint trouble begins with great suddenness, and is often ushered in by chilly sensations or by a distinct chill. Moderate fever arises. The pain in the joint, severe from the first, becomes excruciating. If superficial joints suffer, the skin over them becomes red and hot, and periarticular edema soon presents itself. The fluid in the joint is in most cases serous, but may become purulent. If pus forms, the fever becomes very high and chills may occur.

A chronic condition may follow the acute, but the condition may be chronic from the start. The symptoms resemble those of the acute form, but are far milder, although acute exacerbations may occur. The joint fluid is usually serous.\* In gonorrheal arthritis there may be transitory, intermittent, and wandering pain in and about the joint, without any other symptom; one or more joints may become swollen and painful, and moderate fever may develop. One joint, especially the knee, may swell to an enormous extent, pain, pariarticular edema, redness, and fever being absent (hydrarthrosis, or dropsy of the joint). Suppuration in this form of the disease seldom occurs. The tendons, the tendon-sheaths, the bursæ, and the periosteum may inflame. Whether the joints are inflamed or not inflamed, the tendonsheaths about the wrist and ankle and the retrocalcaneal bursæ may suffer. In some cases numerous bursæ are involved. It is often difficult and is perhaps impossible to check gonorrheal arthritis. It may last for a long period, and tends to recur again and again. Iritis, pleuritis, endocarditis, and pericarditis have been observed as complications.

The diagnosis between gonorrheal arthritis and acute rheumatism rests chiefly on the great chronicity, the slight degree of fever, the excessive ten-

<sup>\*</sup> See Schuller in Aerztl. Pract., No. 17, 1896.

dency to recurrence, and the absence of profuse acid sweats in gonorrheal rheumatism; and on the shorter course, the higher fever, the profuse acid sweats, the lesser tendency to rapid recurrence, the greater proneness to symmetrical involvement, and the great liability to cardiac and visceral complications in rheumatic fever. Furthermore, in gonorrheal arthritis a gonorrheal infection (urethral or ocular) certainly exists or recently existed; in ordinary rheumatism a urethral discharge may, of course, happen to be present. Gonorrheal arthritis is apt to affect certain joints which acute rheumatism rarely attacks.

Treatment.—Because of the lingering character and dangerous nature of gonorrheal arthritis and because if unchecked it is liable to produce grave impairment of function, treatment should be prompt and radical, as advocated by Halsted nearly twenty years ago. The joint should be aspirated and if the fluid obtained contains gonococci or any pyogenic bacteria, the joint should be opened and irrigated. If pus is absent and the case not very violent, the wound can be closed without drainage. If pus is found by incision, irrigate, drain, and immobilize. Conservative treatment is of little value in gonococcal arthritis. The salicylates, the alkalies, and salol are useless; iron, arsernic, and strychnin are possibly of some benefit. Quinin is helpful in some cases. Iodid of potassium seems to be of a certain amount of value. The inflamed joints are usually wrapped in cotton and bandaged, and every day a little blue ointment is rubbed into the skin about them. If the inflammation lingers, it is customary to use the hot-air oven, massage, and gentle passive motion, apply blisters, or counter-irritate with the hot iron. It is thought by some competent clinicians that antigonococcic serum possesses distinct value, greatly alleviating pain and favoring the restoration of joint mobility. My experience with it is as yet too insignificant to justify me in expressing an opinion.

The value of vaccine treatment (injections of dead bacteria) is as yet undermined.

Pneumococcus Arthritis.-This is a rare condition, although Herrick has collected 52 cases ("Amer. Jour. of Med. Sciences," July, 1902). Examina tion of the blood may or may not discover pneumococci, and pneumococci may be found in the blood during pneumonia, when the joints are free from disease. The inflammation may attack any joint, but is most apt to arise in a joint weakened by previous injury or damaged by rheumatism or gout. Alcoholics are more prone to suffer than others. In a great majority of cases the disease is associated with lobar pneumonia, but Cole's case proves that the lung may be free ("American Medicine," May 31, 1902). As a rule, a single large joint is attacked, and the knee is most liable to suffer. The synovial membrane alone may be involved or cartilages may suffer and bone be attacked. The fluid may be serous, but is usually purulent (Herrick). I have seen 2 cases: in one case the knee only was involved; in the other, both knees, one elbow, and one shoulder were attacked. In Cole's series of 41 cases, 13 exhibited involvement of more than one joint. The inflamed joint is frequently completely destroyed. Pneumococcus arthritis develops, as a rule, soon after the crisis of pneumonia, but Herrick says it may arise as late as three weeks after the crisis.

The diagnosis is made by the history of pneumonia, the development

of septic symptoms, and the signs of joint inflammation. It is confirmed by aspiration and examination of the fluid. The disease is very fatal. In Herrick's series of cases over 65 per cent. were fatal. In Cole's series of cases there were 28 deaths and 13 recoveries. Even if the patient recovers, the convalescence is prolonged and more or less ankylosis is to be expected.

Treatment.—A non-purulent effusion may be treated by aspiration if bacteria are not found in the fluid. If the aspirated fluid contains bacteria, the joint should be opened and drained.

Syphilitic Arthritis.—See page 322.

Acute Rheumatic Arthritis; Rheumatic Fever or Acute Rheumatism.—Acute rheumatism is a self-limited febrile malady whose characteristic features are polyarthritis, profuse acid sweats, and a tendency to heartinvolvement. There is some evidence to indicate that acute rheumatism is a form of infective arthritis, the bacteria being deposited in the synovial tissues and later perhaps entering into the joint cavity. Arthritis of many joints has followed intravenous injection into animals of diplococci obtained from the throat of a man suffering from rheumatic angina (Povnton and Paine at Manchester meeting of the Brit. Med. Assoc., 1902). John O'Conor\* believes that acute rheumatism is a condition "something similar to gonorrheal arthritis and pyemia, the germ or toxin gaining admission to the body through the tonsil or other microbic trap-door, and that the joint invasion is promptly followed by a form of infective arthritis accompanied with general toxemia; and, furthermore, the infected joints serve as incubators where the poison is elaborated and passed into the circulation and thus conveyed to other articulations and to the heart."

Symptoms of Acute Rheumatism.—In acute rheumatism the case begins with malaise and fever, and one or more joints become affected. The inflammation spreads from joint to joint, is apt to be symmetrical, and when it arises in fresh joints, usually disappears quickly in those previously affected. The temperature is high, the skin sweats profusely, the joints are red, swollen, hot, and excruciatingly painful, and the structures about the joints are edematous. After a short time the inflammation subsides in one joint and passes into another, the joint first attacked regaining its functions. Suppuration does not take place. Anemia is pronounced, exhaustion is profound, the sweat is sour, the saliva is acid; the urine is acid, scanty, high-colored, often contains albumin, and is deficient in chlorids. Cardiac disease is apt to be produced (endocarditis, pericarditis, or myocarditis). Nodules may form upon fibrous structures hyperpyrexia is not unusual, and cerebral or pulmonary complications may occur.

Chronic Rheumatism.—Sometimes follows repeated attacks of acute rheumatism, but oftener arises insidiously in people who have been exposed to cold and damp, who have suffered from poverty, hardship, and privation, or have had much worry. The capsule and tendon-sheaths thicken, and there is usually but little effusion in the joint, but the articulation becomes stiff and painful. The joint-cartilages are occasionally eroded. Muscular atrophy occurs.

Symptoms of Chronic Rheumatism.—In chronic rheumatism the affected joints are stiff and painful and are a little swollen, but not red. Dampness

<sup>\*</sup> Lancet, Jan. 24, 1903.

and cold aggravate the symptoms. One joint or many may be affected, but usually several are involved. Passive movements cause the joint to creak and develop crepitus in the tendon-sheaths. The muscles are wasted. Anernia is usually pronounced. The smaller blood-vessels become surrounded by fibrous tissue which progressively contracts and lessens the blood-supply of the synovial structures. The joints may ankylose. There is no fever and no tendency to suppuration, and the disease is incurable.

The treatment of acute rheumatism comprises the use of alkalies, salicylates, etc. (See a book upon practice of medicine.) O'Conor is a believer in in cising and draining the inflamed joints; and if the theory of an infective origin is correct, this treatment is rational. I have never ventured to do it, but would consider the advisability of doing so if the ordinary treatment proved futile. O'Conor operates early and believes that this is the real way



Fig. 343.—Chronic gout (Patterson).

to arrest the disease and prevent complications, but his views have not met with general acceptance.\* In chronic rheumatism maintain the general health of the patient, give courses of iron, arsenic, and strychnin, and an occasional course of iodid of potassium or a salt of lithium, and, if possible, send him every winter to a warm climate. Turkish baths give considerable temporary relief. The waters and regimen of Carlsbad and Vichy are of positive though temporary benefit, and the sufferer may obtain relief at the hot springs of Virginia. The patient must avoid damp and must wear woolens. Frictions, the douche, massage, flying blisters, counter-irritation with the hot iron, ichthyol ointment, and mercurial ointment are of benefit. Subjecting the diseased joint to a very high temperature by placing it daily in a hot-air apparatus often does great good. In partial ankylosis it is proper in some cases to give ether and break up the adhesions.

Gouty arthritis, which appears especially in the smaller joints (as the fingers and the metatarsophalangeal joints of the great toes), is due to a deposition of urate of sodium in the joint and in the periarticular structures. The irritant urate of sodium causes inflammation, inflammation leads to the formation of granulation tissue, granulation tissue is converted into fibrous tissue, and the fibrous tissue contracts and thus deforms the joint and limits its mobility. A great mass of urates in a joint constitutes a "chalk-stone."

Symptoms.—The premonitory symptoms may be observed for a day or so, but the acute seizure usually occurs early in the morning, the patient, as a rule, being aroused by excruciating pain in the metatarsophalangeal articulation of one of the great toes. The joint swells, and the skin over it feels hot to the touch and becomes red and shiny. There is often considerable fever. After a few hours the intensity of the seizure abates, only to recur again with renewed violence early the next morning, these remissions and recurrences taking place for six or eight days, when the attack subsides. In patients with chronic gout (Fig. 343) many joints are stiffened and deformed as a result of repeated attacks. Chalk-stones form, and the skin above them may ulcerate. Such patients are chronic dyspeptics, have high-tension pulses, their hearts are hypertrophied, and their urine contains albumin and casts.

The *treatment* of gouty arthritis belongs to the physician, and not to the surgeon, although to the latter the symptoms of the disease should be known, so that it may be diagnosticated from other maladies.

Osteo-arthritis (Rheumatoid Arthritis; Arthritis Deformans; Rheumatic Gout.—In this disease, which is not a combination of gout and rheumatism, the synovial membrane and cartilages are affected, the periarticular structures are involved, and masses of new bone are formed.

Osteo-arthritis probably has, as John K. Mitchell long ago pointed out, a nervous origin. It arises especially in persons who have been worried, driven, and harassed. There is apt to be muscular atrophy, trophic lesions of the hair and nails are likely to appear, and the symptoms are disposed to be symmetrical. The causative lesion has not been determined. The disease is commoner in women than in men. The greatest liability exists between the ages of twenty and forty, but children may acquire the disease, and it may also be developed in people far beyond middle life. Apes in captivity may develop it. Arthritis deformans may attack the rich or the poor; it does not result from gout, nor does it often follow rheumatism; it is not caused by damp and cold; and only in rare cases does it arise after traumatism of a joint.

Osteo-arthritis differs from gout in the entire absence of urate deposit, and it differs from chronic rheumatism in the extensive alterations in the joint-structures. The changes begin in the cartilage; the cartilage-cells multiply, the intercellular substance degenerates, the pressure of the bone causes thinning, and at length the cartilage is entirely destroyed and the bone exposed. The exposed bone is altered in shape, is hardened, and is worn away in the center, the periphery increasing in thickness by ossific deposit, the center deepening by absorption. The margins are not only thickened, but are bulged and lengthened by deposit. The fringes of the synovial membrane hypertrophy and multiply, and some of them are apt

to break off (loose cartilages). The capsule and the ligaments of the joint, as a rule, become fibrous and contract; but they may soften, relax, and permit of dislocation. The joint usually contains no effusion, but in some cases there is great effusion (hydrarthrosis). The tendons about the joint may become fibrous and contracted, they may ossify, they may be separated from the bone, or they may be destroyed entirely. Deformity is marked and motion is limited. The fingers, when involved, show nodules on the sides of the joints (Heberden's nodules). The vertebræ may be involved. Almost all the joints may suffer. Suppuration does not occur.

Symptoms.-Charcot divides osteo-arthritis into three forms, and gives

their symptoms, as follows:

I. Heberden's nodosities, which condition is commoner in women than in men, comes on between the ages of thirty and forty, and is especially common in neurotic subjects. The interphalangeal joints become the victims of attacks of moderate swelling and of some tenderness, which attacks are not severe, but recur again and again. After a time small hard swellings (nodosities) appear upon the sides of the dorsal surface of the second and third phalanges, remain permanently, and slowly increase in size. The joints become stiff and creak on movement, the cartilages are destroyed, and contractions and rigidity develop, but there is no fever and the larger

joints are not involved. The malady is incurable.

2. Progressive rheumatic gout, which may be acute or chronic. The acute form begins as does rheumatic fever. There are moderate fever and swelling, without redness, of a number of joints, of bursæ, and of tendon-sheaths; the joints are stiff and crepitate, and are apt to be symmetrically involved; muscular atrophy begins early and rapidly becomes decided; pain is slight. This acute form is apt to arise in young women after pregnancy, but is not unusual at the climacteric and in children. Anemia always exists. The case is apt to advance progressively until a number of joints are firmly locked, when it may become stationary. Another pregnancy will develop anew the acute symptoms. In the chronic form swelling and pain on movement are noted in certain joints. The involvement is apt to be symmetrical. Attacks of swelling and pain alternate with periods of quiescence, but the disease does not cease its advance. Articulation after articulation is attacked by the malady until almost all the joints are involved; deformity and stiffness become pronounced, and pain may or may not be severe. There is no fever. Muscular atrophy is marked.

3- Partial rheumatic gout attacks one articulation, and it is most often met with in old men. It may fix itself on the vertebral column, on the knee, on the shoulder, on the elbow, or on the hip. The joint grates and becomes stiff, swollen, and deformed; the muscles atrophy; there is usually pain, but

fever is absent.

Osteo-arthritis or partial rheumatic gout of the hip-joint seldom occurs before the age of forty-five, but is occasionally, though very rarely, met with in persons under twenty-five. If the disease arises in an elderly person, it is often called morbus coxæ senilis. In some cases only the hip-joint is attacked; in many cases other joints are also diseased. Osteo-arthritis of the hip may follow an injury. Usually the disease is unconnected with traumatism, begins very gradually, and advances slowly. There is pain,

often mistaken for sciatica, in and about the joint, and there is increasing stiffness. The pain and stiffness are worse when the patient first moves after resting. Lameness becomes noticeable, and grating can be detected in and about the joint. The symptoms become gradually worse, although at times they may seem to improve for brief periods. The lameness and the stiffness are greatly aggravated, and the pain becomes very severe, even when at rest. Shortening takes place, the great trochanter ascends above Nélaton's line, the limb is usually abducted, but in very rare cases is adducted, and finally ankylosis occurs.

Partial rheumatic gout of the vertebral articulations causing fixation is

called "spondylitis deformans" (p. 866).

Treatment.—Osteo-arthritis cannot be cured, but in some cases it remains stationary for many years. Treat the anemia by iron, arsenic, nourishing food, and have the patient out in the fresh air as much as possible. Debility is met by the administration of strychnin. Hot baths of mineral water do good. It is claimed that the hot-air apparatus is of service. Douches improve these cases, but electricity is useless. Counter-irritants do no good. Massage retards the progress of the case, relieves the pain, aids in the absorption of effusion, and delays fixation. During an acute exacerbation the joint should be put at rest for a time and evaporating lotions applied. In an exacerbation in disease of the hip the patient should be put to bed and have extension applied. The patient is unfortunately liable to develop the opium-habit. If dropsy of a joint arises, try compression with a Martin bandage, and, if this fails, aspirate and wash out the joint with a 2 per cent. solution of carbolic acid. Patients with rheumatic gout do best in a warm, dry climate. Cod-liver oil does good, as it improves nutrition and hence retards the progress of the disease. Do not be tempted to immobilize the joints beyond a day or two: fixation only hastens ankylosis. Howard Marsh\* maintains that, as a rule, but little good comes from manipulation. He makes the following exceptions: when one joint only is affected; when the joint is very stiff but not very painful; when the patient is in good general health and is not beyond middle age.

Charcot's Disease (Tabetic Arthropathy; Charcot's Joint; Neuropathic Arthritis).- This condition is an osteo-arthritis due to trophic disturbance, arising in a sufferer from locomotor ataxia, and is anatomically identical with osteo-arthritis, which was described above. The knee is most apt to be attacked, and the hip suffers more often than any joint but the knee. The condition may develop in the shoulder or elbow. The smaller joints sometimes, though seldom, are involved. More than one joint may suffer. The disease in most cases begins acutely, often as a sudden effusion, which after a time may disappear. In most cases, however, the joint becomes rapidly disorganized. The swelling is usually very marked and is sometimes enormous. In the earliest stages it is due to periarticular edema and to articular effusion. Pain is slight or is absent, there is no constitutional involvement, and the condition is unconnected with injury. Some cases begin without this preliminary acute swelling, disorganization being manifest from the beginning. When disorganization has once begun, it continues inexorably. Bony masses form around the articular cavity, in the ligaments, and in the

<sup>\*&</sup>quot; Diseases of the Joints and Spine."

cartilages. The bones and cartilages are rapidly destroyed and absorbed; fracture is apt to occur; the joint creaks and grates; the softening and relaxation of the ligaments permit an extensive range of movement; great deformity ensues; dislocation is apt to occur; muscular atrophy is decided; and pus occasionally, though very rarely, forms. There is not the slightest disposition to repair. Charcot's joint differs from rheumatoid arthritis in the usual acute onset and the painless course. The complete or nearly complete freedom from pain is one of the most striking features of the condition. In saying there is freedom from pain we mean freedom from pain in the joint, from the pain and tenderness in the regions in which we expect to find them in an inflamed joint. Usually these patients, though free from pain in the joint, suffer much from the lightning pains of locomotor ataxia. Gastric crises are not uncommon (Bramwell). Charcot's joint is more common in female than in male tabetics. In saying that Charcot's is often of sudden origin, we mean in a single night, as Charcot pointed out, swelling of a joint may arise. In a day or two the joint swelling becomes great, and if aspiration is performed, yellow serum is obtained. In a week or two the joint begins to creak on movement.

Treatment.—The treatment of Charcot's disease consists in the wearing of an apparatus to sustain the joint. Resection is recommended by some, but most surgeons do not advise its performance. Southam advocates amputation for certain cases of Charcot's joint. He has performed the operation on four patients. He amputated twice for ankle-joint disease and twice for disease of the tarsus. In every case the stumps healed quickly and without suppuration. Southam was lead to perform amputation on his first case by the report of Jonathan Hutchinson's case of amputation of the leg for perforating ulcer and disease of the bones of the foot in a tabetic.

Osteo-arthropathie Hypertrophiante Pneumique (Marie's Disease).—
A condition associated with, and possibly springing from, pulmonary disease, and characterized by enlargement of joints, thickening of the finger-ends, and the formation of a dorsolumbar kyphosis. The joints are painful, the skin undergoes pigmentation, and profuse perspiration is often present. The head entirely escapes in this disease, which immunity marks a distinction from acromegaly.

Hysterical joint (Brodie's joint) is a condition mostly encountered in young women. The disease occurs most commonly in the knee and the hip, and often follows a slight injury which acts as an autosuggestion, a latent hysteria being awakened into action and localized, though severity of the injury does not determine the severity of the symptoms. The disease may ensue upon a synovitis or an arthritis, or may arise without apparent cause. The patient complains of pain in and stiffness of the joint, resists passive motion strenuously, and claims that it causes much pain. There is occasionally some muscular atrophy from want of use, and the joint is a little swollen. The skin is hyperesthetic, and a light touch causes more pain than does deep pressure. The muscles may be rigid. The joint may be maintained either in flexion or in extension, but it is rarely in the exact degree of flexion assumed for ease in a true joint-inflammation, and the position is apt to be changed from day to day or from hour to hour. The skin is usually pale and cool, but may be red and hot, because of hyperemia. A periodically developed heat may be observed, especially at night, accompanied ap-

motions, and frictions.

parently by much pain. The alleged pain in some cases is neuralgia, but in most cases is a pain-hallucination. There is no effusion into the joint, and swelling does not exist, although occasionally there is slight periarticular edema. In some rare cases organic disease arises in a hysterical joint.

Hysterical phenomena are seldom isolated, but are associated with certain stigmata which may be latent. These stigmata are concentric contraction of the visual fields, pharyngeal anesthesia, convulsions, hysterogenic zones, globus hystericus, clavicus hystericus, zones of anesthesia, especially hemianesthesia, and hyperesthetic areas. Such patients are predisposed by inheritance, and have previously, as a rule, had nervous troubles. Hysterical phenomena, be it remembered, lack regularity of evolution, and are produced, altered, or abolished by mental influences and physical sensations which are without effect in causing, modifying, or curing organic disease. The general health, as a rule, is good, but neurasthenia may coexist. In examining these patients the observer will note that the symptoms disappear when the attention is diverted; that they are out of all proportion to the local evidences of disease; that there is no sign of joint-destruction; and that a light touch may cause more pain than does firm pressure. If the patient is anesthetized, perfect joint mobility will be found.

Treatment.—The treatment for a hysterical joint comprises attention to the general health, the employment of nourishing and easily digested food, the prevention of constipation, and the administration of tonics if they are needed. The surgeon must dominate his patient's mind and make her realize that he is master of the case. He is to be an inexorable but just ruler—never a brutal or a cruel one. If possible, send the patient away from the harmful sympathies of her home and let her have the rest treatment of S. Weir Mitchell. Local remedies applied to the joint do harm, as a rule by concentrating afresh the patient's attention upon the articulation, although the hot iron sometimes does good. Suggestion in the hypnotic state may be tried. The use of morphin should be avoided as being the worst of enemies. Never immobilize the joint, and always use massage, passive

Neuralgia of the joints as an independent, isolated affection is extremely rare, though as a complication of other diseases it is by no means uncommon. Neuralgia is more common outside of the joints than in them, and periarticular neuralgia is especially frequent about the knee and the ankle, Joint-neuralgia may arise in any person, but it is more commonly present in young neurotic females. The pain may be persistent, or it may occur in periodic storms, and it is often associated with neuralgia in other parts. The pain may be dull and aching, but it is more often sharp and shooting. Joint-neuralgia is associated with tenderness on pressure, soreness on motion, often with transitory swelling without redness, and sometimes with numbness of the extremities. The diagnosis depends on the temperament of the patient, the sudden onset of the pain, the absence of constitutional symptoms, and the free mobility of the joint, especially under ether. Articular neuralgia may depend upon disease or injury of the central nervous system, upon malaria, syphilis, neurasthenia, rheumatism, gout, hysteria, and neuritis, and may be due to reflected irritation, especially from the ovaries, the uterus, or the rectum.

Treatment.—The treatment to be observed in joint-neuralgia is to main-

tain the general health. Examine for a possible exciting cause, and, if found, remove it. Give a long course of iron, quinin, and strychnin or arsenic. In rheumatic or gouty subjects administer suitable drugs and insist upon the use of a proper diet. During the attack use phenacetin. Morphin must occasionally be given in severe cases, but be careful of it, and never tell the patients they are taking it, as there is a possibility of their forming the opiumhabit. Locally, employ frictions, ointment of aconite, heat, and keep upon the part a piece of flannel soaked in a mixture of soap liniment, laudanum, and chloroform (Gross). Never allow the joint to stiffen; any tendency to stiffness should be met by daily massage, frictions, passive motion, and hot and cold douches. In some rare cases nerve-stretching or neurectomy becomes necessary.

Articular Wounds and Injuries.—A penetrating wound is very serious, and it may be due to a compound fracture, to a compound dislocation, to a gunshot-wound, or to a stab. If a bursa near a joint be injured, secondary penetration may occur as a result of suppuration. In a penetrating wound, besides pain, hemorrhage, and swelling, there is a flow of synovial fluid. A small amount of synovia flows from an injured bursa, a large amount

from an open joint.

Treatment.—If a joint is opened aseptically (as when incised by the surgeon), the wound heals nicely under rest and antisepsis. If a joint is opened by a septic body, suppurative arthritis is apt to arise, and the surgeon endeavors to prevent it by asepticizing the surface, irrigating the joint, draining, applying antiseptic dressing, and securing rest. Normal salt solution is the best agent for irrigation, as it does not injure joint-endothelium. Active anti-septics are apt to lessen tissue-resistance, and thus may actually favor infection. In gunshot-wounds inflicted by pistol bullets or sporting rifle bullets, if antisepsis is not employed, suppuration is inevitable; hence military surgeons in the past, as a rule, have advocated amputation or excision in guns hot-splinterings of large joints. Recent experience shows that the wound of a large joint produced by a hard-jacketed and small-caliber bullet may heal with little trouble. In articular wounds the surface is sterilized, and usually the wound is enlarged, the finger is introduced to discover and remove forcign bodies, through-and-through drainage is secured, a tube is inserted, the joint is irrigated, antiseptic dressings are applied, and the extremity is placed upon a splint. Very severe joint-injuries demand resection or even amputation. Ankylosis, more or less complete, often follows a gunshotwound of a joint. If the joint suppurates, the drainage must be made more free, sinuses must be slit up and packed, sloughs must be cut away, dead bone must be gouged out, and the patient must be placed upon a stimulant and tonic plan of treatment. The above remarks do not apply to wounds inflicted with the modern military projectile. Such wounds are not of necessity infected, and recovery may be prompt and uneventful if the surface is sterilized and antiseptic dressings and splints are applied.

Sprains.—A sprain is a joint-wrench due to a sudden twist or traction, the ligaments being pulled upon or lacerated and the surrounding parts being more or less damaged. A sprain is often a self-reduced dislocation (Douglas Graham). The joints most liable to sprains are the knee, the elbow, and the ankle. The smaller joints are also often sprained, but the

ball-and-socket joints are infrequently sprained, their normal range of free movement saving them; they do occasionally suffer severely, however, as a result of abduction. In a bad sprain the ligaments are torn; the synovial membrane is contused or crushed; cartilages are loosened or separated; hemorrhage takes place into and about the joint; muscles and tendons are stretched, displaced, or lacerated; vessels and nerves are damaged; the skin is often contused; and portions of bone or cartilage may be detached from their proper habitat, though still adhering to a ligament or tendon (sprainfractures). Sprains are commonest in young persons and in adults with weak muscles. They happen from sudden twists and movements when the muscles are relaxed. A large part of the support of joints comes from muscles, and when they are suddenly caught unawares they do not properly support the joint, and a sprain results. A joint once sprained is very liable to a

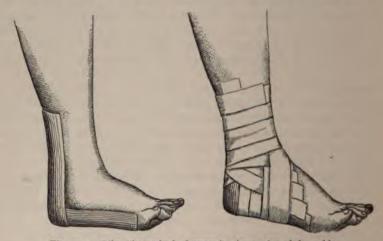


Fig. 344.—Gibney's method of strapping in sprains of the ankle.

repetition of the damage from slight force. Sprains are common in a limb with weak muscles, in a deformed extremity in which the muscles act in unnatural lines, and in a joint with relaxed ligaments.

Symptoms.—There is severe pain in the joint, accompanied by general weakness. Nausea, vomiting, and even syncope may occur. There is impairment or loss of ability to move the joint. The above-described condition is succeeded by a season of relief from pain while at rest, numbness being complained of, and pain on motion being severe. Swelling arises very early if much blood is effused. In any case swelling begins in a few hours. Extensive effusion, by separating joint-surfaces, produces slight lengthening of the limb. Movements of the joint become difficult or impossible; the tear in the ligament may sometimes be distinctly detected by the examining fingers; pain and tenderness become intense; joint-crepitus will be manifested; and in a day or two discoloration becomes marked. Moullin and others have pointed out that when a muscle is strained the skin above it becomes sensitive, especially at tendinous insertions over joints. As muscles are invariably strained when a joint is sprained, there is always some cutaneous tenderness. There is also

tenderness over a sprained joint due to capsular injury, bands of adhesions, etc. Tenderness is apt to arise at certain reasonably fixed points: in a hip-joint injury it is found behind the great trochanter, in a knee-joint injury by the side of the patella, in an ankle-joint injury to the inner side of the external malleolus (Culp). When the vertebral articulations are sprained, the muscles of the back are rigid, the skin is often sensitive, pain may be awakened by pressure or by certain movements, but there is no sign of cord injury in an uncomplicated case.

Diagnosis and Prognosis.—Sprain-fractures can be diagnosticated with certainty only by the x-rays. In the diagnosis of a sprain, fracture and dislocation must be considered. In fracture, crepitus and mobility exist; in dislocation, rigidity. The diagnosis of sprain should be made by a consideration of the joint involved, of the age, of the nature of the force, of the length of the limb, of the fact that the patient could use the joint for at least a short time after the accident, and of the local feel and movements of the part. In some cases examine under ether, in some apply the x-rays. Many injuries about the ankle which we would have formerly regarded as sprains, are often shown by the x-rays to be fractures. The prognosis depends on the size of the joint, on the extent of laceration, on the amount of intra-articular hemorrhage, and on the age of the patient. The danger is ankylosis. In rare cases after a sprain of the hip-joint osteo-arthritis arises. In some few cases after a sprain of the head of the bone undergoes absorption.

Treatment.—In a mild sprain apply at once a silicate or plaster-of-Paris dressing. The first indication after the infliction of a severe sprain is to arrest hemorrhage and limit inflammation. For the first few hours apply pressure and an ice-bag. Wrap the joint in absorbent cotton wet with iced water, apply a wet gauze bandage, and put on an ice-bag. After some hours place the extremity upon a splint and to the joint apply flannel kept wet with lead-water and laudanum, iced water, tincture of arnica, alcohol and water, or a solution of chlorid of ammonium. These evaporating lotions produce cold. Instead of them, an ice-bag may be used for a day or two. Leeches around the joint do good. Constitutionally, employ the remedies for inflammation. Morphin or Dover's powder is given for the pain. Judicious bandaging limits the swelling.

After a day or two, if the symptoms continue or if they grow worse, use hot fomeratations, the hot-water bag, plunge the extremity frequently in very hot water, or apply heat by Leiter's tubes. When the acute symptoms begin to subside, rub stimulating liniments upon the joint once or twice a day and employ firm compression by means of a bandage of flannel or rubber. Frictions should be made from the periphery toward the body. Many cases do well at this stage under the local use of ichthyol and lanolin (50 per cent.), fincture of iodin, or blue ointment. Later in the case use hot and cold douches, massa see, frictions, passive motion, and the bandage. Passive motion is begun a day or so after swelling ceases. If massage causes the swelling to return, abandon it for several days and then try it again. Blisters are used when tender spots persist and stiffness is manifest. If stiffness becomes marked, move the joint forcibly. Give iodid of potassium and tonics internally, and insist on open-air exercise. If the person is gouty or rheumatic, use appropriate remedies. Van Arsdale treats sprains by massage almost from the start. Gibney treats them by strapping with adhesive plaster. Gibney's dressing is

of great service in a sprain of the ankle (Fig. 344). Many sprains may be put up in an immovable dressing the first day or two after the accident. If the joint contains much blood, aspiration should be practised before the dressing is

applied.

The hot-air oven is a very valuable method for treating recent sprains, and the swelling, pain, and stiffness which follow sprains, of the extremities. The sprained extremity is placed in an oven, and the part is subjected to heat for an hour. The next day the treatment is repeated, and on as many subsequent days as may be necessary. In an acute sprain the pain often disappears during the first application of heat. In the intervals between the use of the oven the

extremity should be at rest upon a splint.

Sprain of the Sacro-iliac Articulation.—A fall, lifting a heavy weight, a blow, or a twist may injure this articulation. Normally there is slight motion, rupture or stretching of ligaments may lead to increased motion, and any considerable range of motion at the synchondrosis means lack of solidity and want of support. A sprain of this articulation may be caused by parturition, and also, as shown by Dunlop, it may develop during anesthesia, because of obliteration of the normal lumbar curve by lying on a flat table without a support under the lumbar region ("N. Y. Med. Jour.," July 10, 1909). Dunlop thus explains, and I think truly, the severe backache which is so common after anesthesia.

A sprain causes severe pain, greatly aggravated by standing, by rising up from recumbency, by movements of the ilia which jar the joint, and often by direct pressure upon the synchondrosis. There is often lateral spinal curvature due to spasm, and the concavity is toward the injured side.

There is pain in the injured articulation, but there may be a general backache, and, just as in sacro-iliac tuberculosis (page 632), there may be

pain in the sciatic nerve, in the groin, and in the hip-joint.

When the ligaments become distinctly relaxed we get the chronic condition described by John Dunlop ("N. Y. Med. Jour.," July 10, 1909) and which he calls sacro-iliac relaxation. When this exists the individual may injure the articulation again and again because of its unsteadiness, he may now and then have trouble, he may be in a constant condition of helplessness, with backache, groinache, pain in the hip and over the ischial tuberosity, lumbar rigidity producing lateral curvature, etc. I believe with Dunlop in the reality of the condition.

Treatment.—A recent sprain is treated by rest in bed and adhesiveplaster strapping, reinforced by a canvas roller around the pelvis. In a chronic case (sacro-iliac relaxation), insist on rest and apply a spica bandage of plaster of Paris.

Rupture of the Crucial Ligaments of the Knee.—This is a rare injury. Rupture of both ligaments is very unusual except in very grave injury, such as complete dislocation, and then other ligaments are also torn or de-

stroyed.

The anterior crucial ligament instead of rupturing from force may cause avulsion of the tibial spine (page 618). When this portion of bone is not torn off, the ligament itself tears off from the femur rather than from the tibia. The posterior ligament, too, tends to tear off from femur rather than tibia. Pagenstecher ("Deutsch. Med. Wochenschrift," Bd. xxix) believes that the

anterior ligament may be ruptured by forced flexion of the knee and by blows applied to the posterior part of the head of the tibia when the knee is flexed. The same surgeon maintains that the anterior ligament may be ruptured by blows applied to the front of the head of the tibia when the knee is flexed. Pringle ("Annals of Surgery," August, 1907) maintains that the anterior ligament may be ruptured by "flexion, abduction, and internal rotation of the leg at the knee." If the ligaments are ruptured there will probably be abnormal freedom of anteroposterior movement between the femur and tibia.

Pringle ("Annals of Surg.," 1907) states that if, after an injury, the knee joint becomes distended with blood, the inference should be that one or other crucial ligament has been injured or that the tibial spine has been torn off, unless some other lesion is obviously present; that if internal rotation of the extended leg is possible at the knee, or if the head of the tibia can be brought forward on the femur, or if there is unnatural abduction, the indications are that the anterior crucial ligament has been injured or the tibial spine torn off; that injury of the posterior crucial is suggested by the possibility of pushing the head of the tibia backward during flexion of the knee-joint.

In most cases exploratory incision is required to make the diagnosis.

The treatment is to open the joint and suture the torn ligament.

Ankylosis.—When a joint-inflammation eventuates in the formation of new tissue in and about the joint, contraction of this tissue limits or destroys joint-mobility, producing the condition known as "ankylosis." Ankylosis may be complete (bony) or incomplete (fibrous); it may arise from contractures in the joint (true or intra-articular ankylosis) or from contractures in the structures external to the joint (false or extra-articular ankylosis).

There are qualifying terms to indicate the extent of stiffness—viz., false, spurious, true, bony, ligamentous, partial, complete, or incomplete ankylosis. The significance of the above terms will be better appreciated if ankylosis is considered as meaning a stiff joint. It may be stiff without being rigid. Fibrous adhesions produce stiff joints and they become rigid only when bony union takes place between the bones forming a joint.

Spondylitis deformans is bony ankylosis of vertebræ.

Arthritis ossificans is a progressive bony ankylosis in which numerous joints are involved and are finally completely obliterated. It is an ossifying arthritis.

Etiology.—There are various causes—viz., traumatism and eruptive fevers resulting in acute or suppurative synovitis or arthritis, gonorrheal arthritis, tuberculous arthritis, syphilitic affections of joints, bony fixation when a fracture is near or extends into a joint, and osteitis deformans.

Pathology.—In complete—i. e. bony—ankylosis the bones forming a joint become united by callus in much the same manner as bone fragments are united after a fracture, or osseous bridging takes place at one or more places around the joint. Osseous ankylosis is preceded by a more or less prolonged stage of fibrous or partial ankylosis. In fibrous ankylosis, bands of fibrous connective tissue unite the bones forming a joint, thereby limiting the motion. In cases of joint stiffness produced by extra-articular fibrous, tendinous, or cicatricial contracture, the joint proper remains free from adhesions for years, provided it is not and has not been involved in inflammatory action.

Diagnosis of bony ankylosis is usually made without difficulty except where

there are several joints near together, as the carpus, tarsus, and the spine. When there are several joints near together the limitation of motion in one joint is generally compensated for by the excess in mobility of another, thereby rendering the associated parts capable of closely approaching normal function. Fibrous ankylosis is more difficult to recognize, especially if pain accompanies manipulative measures. It is most apt to be confused with fibrous, ligamentous, or cicatricial contractures of soft parts outside of a joint, but having more or less direct functional relations therewith.

Extra-articular thickening may usually be detected by the existence of resistance to free joint motion in one direction only, i. e., that produced by the fibrous contracture while the joint moves freely in other directions. Muscular contracture, whether voluntary or involuntary, is but temporary, and is easily detected by the preternatural rigidity of surrounding parts. In bony ankylosis no voluntary muscular action can be detected, inasmuch as in the process of the formation of the callus uniting the bones the muscles have become atrophied from disuse. Conversely, voluntary muscle action about a joint always indicates that joint mobility is not entirely destroyed.

As muscular rigidity is one of the most important and reliable symptoms of joint inflammation and tuberculous invasion, it is a serious error to anesthetize a patient for examination of a joint until the full significance of the muscular

action has been carefully studied.

Anesthesia removes the pain and abolishes muscle fixation and thus leaves the unguarded joint free for manipulative movements, which are generally prejudicial and rarely beneficial. Where no muscle fixation is present, much may be learned by the careful study of a joint while the patient is anesthetized. We thus determine the character of the adhesions, whether they are extraarticular or interarticular, whether they are fibrous, cicatricial or osseous, and if bony union exists, whether it involves the entire joint or only a portion of it.

Skiagraphs are invaluable helps in making an accurate diagnosis, especially when stereoscopic plates are made. Definite information can thus be obtained as to the character of the uniting material, its extent, and definite location. Positive information will be given as to the relationship of the bones composing the joint, whether there is luxation, subluxation, flexion, or other abnormal position that may influence decision as to the therapeutic measures to be adopted. It is important to remember that a joint very rarely becomes ankylosed in the position of extension. The almost invariable rule is that flexion is the posture of such joints, and the tendency is toward increase of the flexion until bony ankylosis occurs. In the steady progress of the flexion, subluxation is apt to be induced.

Treatment of Intra-articular Ankylosis.—It is most important to prevent the occurrence of ankylosis, or in the event of its becoming inevitable, to avoid postures that will render the parts unfit for future usefulness when

ankylosed.

The most useful position for a stiff joint is a matter of individual opinion; no definite rules have been accepted. In ankylosis of the elbow, the flexed position is more useful in certain occupations than the fully extended arm. In other occupations the extended arm is most useful. In walking when the knee is ankylosed and does not tend toward flexion the extended leg is more useful than the flexed leg, but it is more difficult to manage when sitting.

The hip, when ankylosed at various angles, is made useful by the increased latitude of motion of the other hip and by the compensatory motion of the lumbar spine. To such an extent is the lower spine reciprocal when one or both hips are abnormal that it has been termed the third hip-joint. For general usefulness the best position for an ankylosed hip is 20 degrees of flexion, 20 degrees of abduction, and 5 degrees of external rotation. In this position, when supplemented by reciprocal action of the other hip and by the lower spine, a very closely approaching normal carriage has been obtained in walking, and the sitting posture has been possible.

Each individual joint has its own peculiar requirement and must become a subject for careful study in determining the most useful posture if ankylosis is to be permanent. The trend of modern surgery is to greatly reduce the time of fixation of a fractured bone in order to avoid joint stiffness and prevent muscular wasting. Early passive motion when judiciously employed does not interfere with the efficient treatment of a fracture, but does prevent the joint

stiffness that is often a serious and painful sequel.

Brisément forcé is a term applied to the use of such manipulative force as the surgeon can judiciously employ in freeing a joint from fibrous adhesions. It is important to keep constantly in mind the danger of breaking the shaft of a bone or of separating the epiphysis when unguarded leverage of the entire shaft of the bone is used. It is of paramount importance to avoid brisément forcé in all cases where the ankylosis has resulted from tuberculosis.

In applying manipulative force it is not always advantageous to have the patient profoundly anesthetized. If he is profoundly anesthetized we may be tempted to apply too great force. Great lacerations of fibrous adhesions produce painful joints which necessitates fixation or rest for several days to permit the reunion of the torn structures. A little gain, care being taken to main tain the motion gained, mobility being gradually increased by short progressive steps, is always better than attempts to do a great deal at once. Of course the patient's coöperation is necessary.

When pain is great, much can be accomplished during primary ether anesthesia or while the patient is under the influence of nitrous oxid. Bromid of ethyl and chlorid of ethyl are used by many because of their rapid action and brief effect. As stated elsewhere (page 1205), I seldom use either of these drugs.

Fixation appliances of any kind are contra-indicated during corrective maniful ulations, as increased freedom of motion is essential rather than fixation. Volumetary efforts are needed to maintain the joint's motion already secured as well as to increase the muscle function controlling the affected joint.

to obtain a false joint (pseudo-arthrosis), excision to obtain a better position for the usefulness of the limb, breaking the bone after partially cutting it with an ost cotome (osteotomy), and breaking the bone without any excision (osteo-clasis). These several procedures have special advantages in different joints.

Lexer ("Zeit. f. Chir. Med. Orth.," Oct., 1908, p. 476), after resecting a knee-joint ankylosed at a right angle, transplanted the entire knee-joint apparatus from a freshly amputated limb. Complete union resulted. Muscle training was subsequently practised to improve the weak muscular control.

Weglowski ("Zent. f. Chir.," April 27, 1907) resorted to cartilage transplantation in a case of ankylosis of the elbow. After freeing and re-forming the

ends of the three bones, two plates of cartilage (one-half thickness of rib cartilage) with perichondrium were taken from the sixth and seventh ribs and placed between the newly formed joint surfaces, the perichondrial surface being turned toward the humeral epiphysis. No special fixation was used. No drainage was employed. Active and passive motion was begun on the tenti day. In a month the patient had 60 degrees of free flexion and extension and full pronation and supination. Death from pleuropneumonia of three days duration occurred in five weeks. Postmortem showed that the perichondria surface of the cartilage was united to the humerus, while the opposite side was smooth, even shining; the cartilage was enlarging and passed without definite margin into the surface of the humerus.

Microscopic examination showed newly formed blood-vessels between the cartilage and bone; the cartilage was well preserved in its entire extent, the

cells and nuclei staining well.

Hugier and Murphy advocate a novel plan ("Traitement des Ankylose par la Résection Orthopedique et L'interposition Musculaire," par Le Dr Alphonse Hugier).

J. B. Murphy ("Journal American Medical Association," May 20-27 June 3, 1905) reviews the literature of the attempt to produce new joints and says: "In our work we have been able, by the interposition of fascia and muscle, covered with a layer of adipose tissue, to produce normal movable joints with capsules and collagen intra-articular fluid." In cases of synovitis with adhesions he resects the capsule and replaces it by aponeurosis or muscle and it is desirable, when possible, that the replacing piece contains fat, which under pressure, will form a hygroma or artificial synovial cavity. In bony ankylosis he operates, separates the bones, removes adjacent bony prominences or processes, frees the soft parts, prevents the bones coming again it contact, and interposes between them tissue which will remain fibrous or will form a hygroma or artificial synovial surface. After wound healing has taker place, passive motion, active motion, and forcible extension are required.

W. S. Baer ("Am. Jour. Orth. Surg.," 1907, p. 234) advocates the use of sterilized olive oil injected into joints to prevent the formation of adhesions and thus increase the arc of motion. It may also be poured into a joint after arthrotomy. After using oil in the manner described, Baer summarizes as follows "That injection of oil into joints under proper precautions is a harmless procedure; that the joint will apparently tolerate as much as it will hold.

"It is most useful in cases where adhesions have followed some acut infectious process, or in those stiff joints which are classified as arthritis defor

mans of the infectious type.

"Passive motions are made with less pain where the joint contains oil.

"It plays some part in preventing adhesions, so that the mobility of the joint is increased more rapidly."

In ankylosis of the temporomaxillary joint it was once the custom to wedge the jaws apart with a mouth-gag and afterward insert boxwood plugs of advancing size at frequent intervals. This method invariably fails Esmarch's operation (removal of a wedge-shaped piece of bone from the ramus) is sometimes useful. Some operators excise the condyle and a portion of the neck. Swain saws the bone at an angle.

W. S. Baer ("American Jour. Orthopedic Surg.," August, 1909) review

the literature of the operative treatment to mobilize joints, and advocates the use of chromicized pig's bladder as the most satisfactory material to place

between the surfaces of excised joints. He refers to Helfereich, who, in 1893, mobilized the temporomaxillary joint by the insertion of a flap from the temporal muscle. This was repeated by Lentz, Henle, and others. Mikulicz, in 1895, used a flap from the masseter muscle. Similar procedures were employed by Bilezguski, Hoffa, and Kusnetzow. Rochet and Schnudt with Glück, in 1902, used a skin-flap and had previously employed ivory joints to take the place of the excised structures. Chlumsky, disappointed with the results of muscle flaps, used non-absorbable materials, zinc, rubber, celluloid, silver, and layers of colloidin, but no permanent mobility was obtained. He then employed absorbable plates of decalcified bone, ivory, and magnesium, with somewhat better results. Baer's method of inserting chromicized pig's bladder followed the unsuccessful employment by him of Cargile membrane. The pig's bladder is tightly stitched around the recently denuded bone with catgut sutures and the wound closed. A hip-joint two months after this procedure showed a voluntary flexion of 35 degrees; abduction, 15 degrees; adduction, 10 degrees; rotation, 25 degrees. Seven months after operation the mobility was better than that recorded at two months. Similar results are recorded in knee and elbow.

Baer emphasizes the necessity of having the pig's bladder absorbable in thirty to forty days. It should be pliable enough to be adapted to the contour of the joint. Every raw surface should be absolutely separated by it from that with which it would tend to come in contact.

Treatment of Extra-articular Ankylosis.—The treatment of false ankylosis depends upon the case. Recently contracted muscles or tendons require motion, massage, frictions with stimulating liniments, hot and cold douches, and the use of the hot-air apparatus. Violent breaking up is not satisfactory. neither is tenotomy nor myotomy. Old contractions of tendons require tendon lengthening by tendoplasty or myoplasty. Chronic inflammation of tendonshearths with adhesion of tendons requires excision of the sheaths. Whenever Possible, excise a cicatrix that causes false ankylosis, and fill the gap with sound cutaneous tissue and fat. When the fixation is due to adhesive synovitis of the capsule, excise the capsule and attached ligaments; "the head and neck of the bone should then be surrounded by an aponeurosis or muscle to prevent the reforming of adhesions" (John B. Murphy, in "Jour. Am. Med. Assoc.," May 20-27 and June 3, 1905). Bony deposits are gouged away and tumors are removed. Contractures in cases of paralysis require electricity, passive motion, frictions with stimulating liniments, the hot-air bath, and general trea 1 ment.

Loose Bodies in Joints (Floating Cartilages).—The knee is the joint affected in 90 per cent. of cases, but the elbow, shoulder, hip, wrist, lower jaw, and ankle may suffer. There may be but one loose body in a joint, there may be two or more, there may be many or even hundreds. More than one joint may be involved. The condition is commonest in adult men. These bodies may be free or each may have a stalk or pedicle; they may move about and occasionally block the joint, or may lie quietly in a joint-tecess or diverticulum. They may be flat or ovoid, smooth or irregular, as small as peas or as large as plums, and may be composed of fibrous tissue, of cartilage, or of bone. There are numerous different modes of origin of

these bodies, many being "detached ecchondroses or pieces of hyaline cartilage hanging by narrow pedicles" (J. Bland-Sutton), and they result from enlargement and chondrification of the villi of the synovial membrane.

Symptoms.—Many bodies give rise to no symptoms for a long time and others merely cause synovitis. A loose body may produce pain and interfere with joint-function. The joint is weak and a little swollen, and the patient can perhaps feel the body and often can push it into a superficial area of the joint, where it may be felt by the surgeon. From time to time the body may get caught, thus suddenly locking the joint and producing intense and sickening pain, extension and flexion being impossible until the body slips out. It may slip out in a moment, but may not for hours or even for many days. A rather small body seems more apt to cause locking than a very large one, but if a large one does cause locking, it is more difficult to dislodge than is a small one. Locking of a joint by a loose body is followed by inflammation and effusion. If the loose body is dense or long, the x-ray may disclose it. In some cases of loose body in the knee the diagnosis is impossible from dislocation of a semilunar cartilage, inflamed semilunar, and synovitis with proliferation of villi.

Treatment.—To relieve locking, employ forced flexion and sudden extension. Cure can be obtained only by operation. Let the patient bring the foreign body to a point where it can be felt by the surgeon, so that he can determine where it lodges. Asepticize the knee with the utmost care. Operate if possible under cocain; if not, give ether. If the body is felt before operating, fix it with a pin. The joint is now opened, the foreign body extracted, and an exploration made to see that no other bodies are present. The wound is sutured and the leg is placed upon a splint. Asepsis must be most rigid. The operation does not cure the causative lesion, and these bodies are apt to form again. When the knee is involved, some surgeons saw the patella transversely, open the joint widely, remove all foreign bodies, and seek to cure any causative lesion.

## LUXATIONS OR DISLOCATIONS.

A dislocation is the persistent separation from each other, partially or completely, of two articular surfaces. A self-reduced dislocation is called a sprain (Douglas Graham). There are three forms of dislocations: (1) trau-

matic; (2) spontaneous or pathological; (3) congenital.

1. Traumatic dislocations are due to injury. They are divided into—complete dislocation, in which the two articular surfaces are entirely separated and the ligaments are torn; incomplete or partial dislocation or subluxation, in which the two articular surfaces are not completely separated and the ligaments are rarely lacerated; simple dislocations, in which there is no wound leading from the surface to the articulation; compound dislocation, in which a wound leads from the surface to the joint; complicated dislocation, in which, besides the dislocation, there is a fracture, extensive damage of the soft parts, an opening which makes the case compound, or damage of a nerve or blood-vessel; primitive or primary dislocation, in which the bones remain as originally displaced; secondary dislocation, in which the dislocated bone assumes a new position; for instance, a subglenoid luxation of the humerus is primary, and it may become secondarily a subcoracoid luxation because of muscular contraction or attempts at reduction; recent dislocation, in which

the displaced bone is not firmly fastened by tissue-changes in its new situation, and its old socket is not obliterated; old dislocation, in which the displaced bone is firmly fastened by tissue-changes in its new habitat, and the old socket is to a great extent obliterated (whether a dislocation is old or new depends on the state of the parts rather than on the time which has elapsed since the accident); double dislocation, in which corresponding bones on each side are dislocated; single dislocation, in which only one joint is dislocated; unilateral dislocation, in which one articulation of one bone is out of place; bilateral dislocation, in which symmetrical articulations are dislocated; and relapsing or habitual dislocation, which recurs constantly from slight force because of relaxed ligaments or lack of complete repair after the ligamentous rupture of a first dislocation.

2. Spontaneous, Pathological, or Consecutive Dislocations.—
Spontaneous dislocation arises from such very slight force that the cause may not be identified, and it acts on a joint rendered lax by disease. It may arise in the course of chronic synovitis, tuberculous joint-disease, or rheumatoid arthritis. In Charcot's joint a spontaneous dislocation will occur sooner or later. In typhoid fever spontaneous dislocation is not uncommon. The hip-joint is most often the one attacked. Dislocation in hyphoid jever generally occurs at the hip-joint, follows a severe joint inflammation, is usually upon the dorsum of the ilium, and is frequently not noticed until convalescence has set in. If a typhoid dislocation is seen early, reduction is easily effected, but if seen late, is impossible. The treatment for irreducible typhoid dislocation is the same as for any other irreducible dislocation.

3. Congenital Dislocation.—A congenital dislocation is due to a congenital joint-malformation which renders it impossible for the bone to maintain a normal position, or is due to external violence during the period of uterine gestation. Congenital dislocations should not be confounded with dislocations produced during delivery. The hip is the joint most often involved. The shoulder suffers occasionally. Lannelongue maintains that congenital dislocation of the hip is due to atrophy of the muscles and of the acetabulum following spinal-cord disease. Verneuil thinks the dislocation is paralytic. Broca says that in view of the fact that the head of the bone is larger than the cavity in which it belongs, it is useless to attempt reduction by manipulation or extension, but many successful cases by the Lorenz bloodless method prove Broca's statement to have been too sweeping. Lorenz and Hoffa have each devised an operation for this condition (pages 723, 724). Congenital dislocation of the shoulder requires incision, possibly exision, or the paring down of the head to fit the glenoid cavity (Phelps).

Traumatic Dislocations.—In the succeeding pages the traumatic form of dislocations will be particularly considered.

The causes of traumatic dislocations are divided into predisposing and exciting.

Predisposing causes are: (1) age; dislocations are commonest in middle life, the usual lesion of the young being green-stick fracture, and that of the old being lracture; dislocations of the radius are not uncommon in youth; (2) muscular development, dislocations being commonest in those with powerful muscles; (3) sex, males being more predisposed than females, because of their occupations and muscular strength; (4) occupation predisposes as a cause

according as it demands the employment of muscular force, as in the carrying of burdens; (5) nature of the joint, ball-and-socket joints being more liable to luxation than are ginglymoid joints, because of their wide range of motion; (6) joint-disease predisposes by relaxing the ligaments; (7) situation of the joint,

some joints being more exposed to injury than others.

Exciting causes are divided into—(1) external violence and (2) muscular action. External violence may be direct, as when a blow upon one of the bones forces it directly away from the other; or it may be indirect, as when a blow at a distant part of a bone transmits force to its end and drives the bone out of its socket. Muscular action is a cause when sudden and violent muscular contraction occurs during the maintenance of a position of the joint which gives the muscles full sway, and throws the head of the bone against the weakest part of its retaining ligaments.

Pathological Conditions.—In a recent complete traumatic dislocation the ligaments are damaged, and may perhaps show extensive laceration, or may show only a buttonhole laceration through which a bone projects. External force produces much laceration and little stretching of the ligaments; muscular action produces little laceration and much stretching of the ligaments. In some cases of dislocation due to external violence the structures about the joint are bruised or otherwise damaged; the old socket is filled with blood, and the bone in its new situation lies in a bloody area. Large vessels

and nerves are rarely torn, though they may be compressed.

If a dislocation is not soon reduced, inflammation arises in the old joint and about the displaced bone, and the whole area is glued together, first by coagulated exudate, and finally by fibrous tissue. After a time, in ball-and-socket joints, the old socket fills with fibrous tissue, contracts, becomes irregular, and may even be obliterated; the head of the dislocated bone is altered in shape, its cartilage is destroyed or converted into fibrous tissue, and the pressure of the head of the bone forms a hollow in its new situation, which hollow becomes surrounded by fibrous tissue or even by bone. A new joint may form, the surrounding tissue becoming a compact capsule, and a bursa forming between the head of the bone and its new socket. In a dislocated hingejoint the ends of the bone alter greatly in shape and their cartilage is converted into fibrous tissue. In an unreduced dislocation the muscles shorten or lengthen or undergo atrophy or fatty degeneration, as the case may be. An unreduced dislocation of a ball-and-socket joint may give a fairly movable new joint, but an unreduced dislocation of a hinge-joint rarely allows of much motion.

General Symptoms of Traumatic Dislocation.—In general, traumatic dislocations are indicated—(1) by pain of a sickening, nauseating character; (2) by rigidity, voluntary motion being impossible except to a slight extent in the direction of the deformity. (For instance, in dislocation of the inferior maxillary the jaw can be opened a little more, but it cannot be closed.) This rigidity brings about loss of function. When the surgeon attempts to move the joint he finds it very rigid; (3) by change in the shape of the joint (as flattening of the shoulder after dislocation of the humerus); (4) by alteration in the mutual relations of bony prominences about a joint (as the alteration of the relation between the olecranon and humeral condyles in dislocation of the elbow backward); (5) by feeling the displaced bone in its new situation; (6) by missing the head of the bone from its proper situation; (7) by alteration

in the length of the limb (in dislocation of the femur into the thyroid foramen the limb is lengthened, but in dislocation onto the dorsum of the ilium it is shortened); and (8) by alteration in the axis of the bone (in dislocation upon the dorsum of the ilium the axis of the injured thigh would, if prolonged, pass through the lower third of the sound thigh); (9) by seeing the dislocation

with a fluoroscope or looking at a skiagraph of it.

Diagnosis of Traumatic Dislocation.—A dislocation may be mistaken for a fracture. In dislocation there is rigidity, in fracture there is preternatural mobility; in dislocation there is no true crepitus (may get tendon- or joint-crepitus), in fracture there usually is crepitus; in dislocation the deformity does not tend to recur after reduction, in fracture it does recur after extension is relaxed. In a sprain the movements of the joint are only limited, not abolished, by the almost complete rigidity encountered in dislocation. The change which a sprain may cause in the shape of a joint is due to effusion or to bleeding; there is no alteration in the relation of the bony prominences to one another; there is no notable alteration in the length of the limb (a slight increase in length may arise from joint-effusion, or the head of the bone may subsequently be absorbed and thus produce shortening after some weeks); there is no alteration in the axis of the bone; the bony head is not felt in a new position, and it is found in its normal place. Always remember that a fracture may exist with a dislocation. In any doubtful case-in fact, in most cases—give ether, for a dislocation should be reduced while the patient is anesthetized (except in dislocation of the jaw, of the fingers, of the carpus, etc.). In some cases swelling renders the diagnosis difficult or impossible. Always compare the injured joint with the corresponding joint of the sound side. The x-rays constitute a valuable aid to diagnosis.

Treatment of Traumatic Dislocations. - Recent Simple Dislocations .-Reduce simple dislocations under ether, as a rule. Try manipulation, a procedure which seeks to make the bone retrace its own pathway. If this procedure fails, employ extension and counter-extension. If considerable force is needed, an assistant makes counter-extension, and the surgeon fastens to the extremity a clove-hitch, which he ties about his waist, and thus secures powerful extension. Counter-extension may be obtained by bands, or, in some instances, by the foot of the surgeon. The clove-hitch is used because it will not tighten by traction; a tightening band would lacerate the soft parts (Fig. 351). If great power is needed, compound pulleys may be employed, such as the Jarvis adjuster or some similar appliance, but at the present day pulleys are rarely used (see page 678). If these means fail, cut down upon the bone and restore it to position; operation is much safer than is the application of great force. After reducing a dislocation, immobilize the joint for a time, which varies for different joints, and for the first few days combat swelling and inflammation by rest of the part and the use of evaporating lotions or an ice-bag. If there exists a fracture of the dislocated bone, apply splints and then try to reduce by manipulations, grasping the limb and the splints with one hand below and, if possible, with the other hand above the seat of the fracture. Allis believes that a dislocation can be reduced even when a fracture exists. It is possible to pull the dislocated head down to the joint, because a portion of periosteum and possibly tendinous material and muscle still hold the two fragments as a strap might unite two sticks. The head can be forced into place by the fingers while traction is being made. If the fracture is near the joint and the fragments cannot be fixed, try to reduce the dislocation, first striving to press the bone into place. This attempt can be greatly aided by traction upon the lower fragment. In some cases with fracture reduction can be much aided by making a small incision, screwing a gimlet into the head of the bone, and using this tool as a handle. McBurney incises, drills a hole in each bone, inserts hooks into them, and pulls the dislocated bone into position (Figs. 250, 251, and 252). When the dislocation has been

reduced, the bone fragments should be wired together.

Compound Traumatic Dislocations.—The opening in the soft parts may be due to external violence or to projection of a bone. Compound dislocations are very serious. Hinge-joints are more liable to these injuries than are ball-and-socket joints. Many cases require excision: some, amputation; one that does not demand excision or amputation should be treated by sterilizing the parts, restoring the dislocated bone, making a counter-opening, draining, dressing antiseptically, and immobilizing. Considerable ankylosis generally ensues, except sometimes in the small joints. It is scarcely ever necessary to cut away any portion of the protruding bone to effect reduction. If a joint is badly splintered, or if the soft parts are extensively damaged, it may be necessary to excise or amputate; if the main vessels of a limb are seriously injured, amputation must be considered. If the patient is so old or so feeble that it is perilous to force him to combat a long illness, amputation should be performed.

Old Traumatic Dislocations.—The problem always presented in an old dislocation is, Shall reduction be tried or shall the bones be let alone? Sir Astley Cooper laid down this rule: "Do not attempt to reduce a shoulder-dislocation after three months, nor a hip-dislocation after two months"; but this rule was put forth before the days of ether. Do not select any fixed period of time to determine what action is advisable. In dislocation of a ball-and-socket joint considerable motion may become possible and a new joint may form. If movement does not produce pain, a useful new joint may be obtained by the persistent employment of active and passive movements; if movement of the limb does produce pain, enough motion will not be attempted by the patient to produce a useful joint. In the former case it may be best to try to obtain a useful new joint, and in the latter case the surgeon should endeavor to reduce the old dislocation. Always remember that dislocation of a hinge-joint, if left unreduced, will never eventuate in a useful new joint.

In trying to reduce an old dislocation give ether, make movement to break up adhesions, and persist in making these motions until the head of the bone is felt to move; then try at once to reduce by manipulation or extension and counter-extension, not waiting for two days, as some suggest. If the head of the bone cannot be made to move, the Dieffenbach plan has been advised, which is to cut the tense restraining bands with a tenotome. Lord Lister, being much impressed with the danger inevitably linked with forcibly dragging old dislocations into place, prefers to cut down and restore the bone, employing, of course, the strictest asepsis, and surgeons in general have adopted this view. In some old dislocations excision of the head of the bone is the proper operation.

Special Traumatic Dislocations.—Lower Jaw.—A dislocation of the lower jaw, when there is no fracture, is almost invariably forward.

Backward dislocation without fracture is extremely rare, and some have maintained that it cannot occur. Croker King reported a case in 1858. Theim has observed it seven times in five women. The condyle passes under the lower surface of the auditory canal.\* The common dislocation is forward, and this is the form meant when we simply speak of dislocation of the jaw. There are two forms of forward dislocation—the unilateral, which is rare, and the bilateral, which is common. Dislocations of the jaw are commonest in women and during middle life. When the mouth is open, contraction of the external pterygoid muscle may pull the condyle over the articular eminence; this contraction may be brought about by yawning, vomiting, scolding, etc. When the mouth is open, dislocation of the lower jaw may be caused by a blow upon the chin; it may also be caused by forcing the mouth more widely open by pushing a bulky body between the teeth.

Symptoms of Lower-jaw Dislocations.- In the bilateral form the mouth is open and fixed, and it cannot be closed, though it can be opened a little more. The condyles are in front of the articular eminences, and are fixed by the action of the masseters and internal pterygoids, the coronoid processes being wedged against the malar bones. The lower jaw is advanced in front of the upper jaw and the face looks longer than natural. The lips cannot close, the saliva dribbles, swallowing and speech are difficult, there is a depression in front of each ear, the condyles are recognizable in their new abodes, the coronoid processes are detected by a finger in the mouth, and the masseters and temporals stand out in a state of rigidity. Pain may be severe, may be moderate, or may be absent. In the unilateral form the chin goes toward the sound side, and the mouth is not so widely open as in the bilateral form. neither is the jaw so fixed. The symptoms are similar to those of a bilateral luxation, but are not so pronounced. The hollow in front of the ear and the abnormal situation of the condyle are detected upon one side only. In an unreduced dislocation the patient may after a time establish some movement of the jaw, but the power of mastication will always be seriously impaired.

Treatment of Lower-jaw Dislocations .- In reducing a dislocation of the lower jaw the patient is placed with his head against the back of a chair or against the body of an assistant. The surgeon, after wrapping up his thumbs to protect them from being bitten, stands in front of the patient, puts his thumbs upon the last molar teeth, and grasps the chin with his free fingers. He now presses downward and backward on the jaw, and as soon as the condyle is loosened, closes the jaw over the thumbs by pushing up the chin, using his thumbs as levers. If this procedure fails, wedges should be put between the molar teeth and the chin should be pushed up either by the hands or by a tourniquet whose band is round the head and chin. In a unilateral dislocation the wedge should be used only on the injured side. In difficult cases Sir Astley Cooper pushed a round wooden ruler between the molar teeth, used the upper teeth as a fulcrum, and raised the end of the ruler as the handle of a lever. The forceps used by an anesthetist may depress the condyle from its point of fixation, whereupon the chin may be pushed up and back. Nélaton advises that the surgeon place his thumbs in the mouth of the patient and push the coronoid processes backward. After reduction a Barton bandage should be applied and worn for over two weeks. The dressing should be renewed once a day, and passive motion

<sup>\*</sup> Theim, in Rev. de Chir., vol. viii, 1888.

is to be begun in the second week. The bandage may be discarded at the end of the third week. Liquid diet is advisable for three weeks after the accident. In an old dislocation reduction is always attempted, at least up to a period of six or seven months after the accident. An irreducible dislocation requires osteotomy of the neck of the bone if the part cannot be restored after incision.

Dislocation of the Clavicle.—Sternal End.—There are three forms of dislocation of the sternal end of the clavicle, namely: (1) forward; (2) back-

ward; and (3) upward.

Forward Dislocation of the Sternal End of the Clavicle.—The causes of forward dislocation of the clavicle are blows, falls, or pulls which drive or draw the shoulder backward.

Symptoms and Treatment of Forward Dislocation of the Sternal End of the Clavicle.—The symptoms manifest in dislocation of the clavicle are:

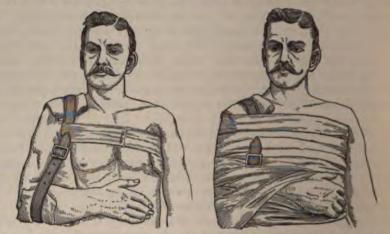


Fig. 345.-Rhoads's apparatus for treating dislocation upward of the acromial end of the clavicle.

prominence in front of the sternum; the acromion is nearer to the sternum on the injured than on the sound side; the clavicular origin of the sternocleidomastoid muscle is rigid; movement is difficult and painful. To reduce a dislocation of the clavicle, pull the shoulders back against the knee of the surgeon, which is placed between the scapulæ. Dress with a posterior figure-of-eight bandage (Fig. 747) or a Velpeau bandage (Fig. 749), the dressing to be worn for three weeks. After removal of the dressing apply a truss, the pad of which is put over the head of the clavicle, and which instrument is to be worn for a month. Dislocation of the clavicle is difficult to keep reduced, but even if it becomes fixed in deformity, the motions of the arm will not be impaired permanently. It can be reduced and fixed by incision and wiring.

Backward dislocation of the sternal end of the clavicle is very rare. The *causes* are direct violence and indirect force, such as falls or blows which drive the shoulder forward and inward.

Symptoms and Treatment of Backward Dislocation of the Sternal End of the Clavicle.—The symptoms are: pain; loss of function in the arm; inclination of head toward the injured side; stiffness of the neck; the shoulder passes forward and inward, and often falls downward; a depression exists over the sternoclavicular joint; the head of the clavicle cannot be felt, or is found back of the sternum. The displaced clavicle may press upon the trachea, the esophagus, or the great vessels, inducing dyspnea, dysphagia, obliteration of pulse in the arm of the injured side, or great venous congestion of the head (see Pick). The usual method of treatment is to pull the shoulders backward and apply a posterior figure-of-eight bandage (Fig. 747), which must be worn for three weeks. If pressure-symptoms are urgent, it is the rule to incise, restore the bone to place and wire it, or resect the displaced head.

Upward dislocation of a clavicle is very rare. The cause is indirect force which carries the shoulder downward, inward, and backward (Smith).

Symptoms and Treatment of Upward Dislocation of the Sternal End of the Clavide.—The chief symptom is impaired function of the arm; the shoulder passes downward and inward, the clavicular axis is altered, and the displaced head is felt. Dyspnea may or may not exist. To treat this dislocation, put a pad in the axilla and press the elbow to the side in order to throw the bone out-



Fig. 346.—Dislocation upward of acromial end of clavicle.

ward, and try to push the head into place. Apply a Desault bandage (Fig. 750) and place a firm pad over the sternoclavicular joint. The deformity is apt to recur, but a useful limb will nevertheless be obtained. The best method of treatment is to wire the bones in place.

Dislocation of the acromial end of the clavicle is almost always upward, but it may be below the acromion. The cause is violent force, which, if so applied to the scapula as to drive the shoulder forward, may produce a dislocation upward. A dislocation downward is due to blows upon the upper surface of the outer end of the clavicle.

Symptoms and Treatment.—In dislocation of the acromial end of the clavicle upward there are noted: prominence of the clavicle upon the top of the acromion; impaired function of the arm (it cannot be lifted over the head); the shoulder falls downward and passes inward; there is apparent lengthening of the arm; the head is bent toward the injured side, and the clavicular origin of the trapezius is strongly outlined (Pick). In dislocation downward both the acromion and the coracoid are very prominent, the clavicular axis is altered, and there is depression over the sternoclavicular joint. The surgeon

## Diseases and Injuries of Bones and Joints

ally endeavors to reduce a dislocation upward by placing the patient oine on a hard table, pulling the shoulder back, and pushing the bone to place. After reduction the old method of treatment was to apply a Deult bandage, which was kept on for three weeks, and decided deformity, nduring pain, and disability were looked for as inevitable. Stimson used o apply dressings of adhesive plaster. The author has seen one case treated by the apparatus of Thomas Leidy Rhoads. The apparatus completely corrected the deformity, and the patient made a most satisfactory recovery. The essential element of Rhoads's apparatus is a trunk-strap applied as is shown in Fig. 345. If the deformity can be completely corrected, Rhoads's apparatus will serve a good purpose, but in many cases it is impossible really to reduce the deformity or after apparent reduction the deformity at once returns. This is due, as Moore points out ("Annals of Surgery," May, 1902) to the fact that the superior acromioclavicular ligament is torn from the clavicle but remains attached to the scapula, and when reduction is attempted, is pushed under the clavicle and nothing remains to hold the clavicle "in place but the skin and superficial fascia." I agree with Moore that the best treatment is incision, replacement, and suturing the acromion to the outer end of the clavicle. The bones are sutured with silver wire or kangaroo tendon, the acromioclavicular ligament is sutured with catgut, the wound is closed with sutures of silkworm gut, and the patient is kept supine in bed for three weeks. I have operated successfully on four of these cases.

Dislocation downward is reduced and treated in the same manner as dislocation upward.

Simultaneous dislocation of both ends of the clavicle is a very rare injury.

It is treated as is single dislocation.

The so-called dislocation of the lower angle of the scapula is not, as was long taught, a dislocation at all. The lower angle and vertebral border deviate from the chest. This condition was thought to be due to the bone slipping from under the latissimus dorsi muscle, but it is now known to be due to paralysis of the serratus magnus muscle, the bone being acted upon by the trapezius, pectoralis minor, levator anguli scapulæ, and rhomboid muscles. Examination shows that the scapula will not rotate normally forward. This is demonstrated by extending the arms in front to a right angle, the gliding forward of the scapula upon the sound side being marked and upon the diseased side, being slight or absent.

Treatment of paralysis of the serratus magnus muscle comprises massage, electricity passive motion, and deep injections of strychniq

Dislocations of the Humerus (Shoulder joint).—These injuries are quite frequent becay of the free mobility of the shoulder-joint, its atomical insecurity, and its exposed situati ly occur in the very young and in the aged, and are ofter



Fig. 347.—Axillary dislocation of the right humerus.

encountered in muscular young adults. Shoulder dislocation is produced by throwing the arm into extreme abduction. In this position the head of the humerus presses against the lower and front part of the capsule, that is, against the thinnest and most poorly supported portion of the capsule. In almost all cases the tear in the capsule occurs between the tendon of the subscapularis and the triceps. Hence, most dislocations are primarily subglenoid, although the bone usually moves to some other position, being dragged or driven there by the injuring force or being pulled there by muscular action. Dislocation forward is much more common than dislocation backward because the long head of the triceps keeps the head of the bone from going posterior and because the anterior are stronger than the posterior muscles. Four chief forms of shoulder-



Fig. 348.—Subcoracoid dislocation of the left humerus (St. Joseph's Hospital case; photographed by Dr. Nassau).

joint dislocation exist, namely: (1) forward, inward, and downward, under the coracoid process—subcoracoid; (2) downward, forward, and inward, beneath the glenoid cavity—subglenoid; (3) backward, inward, and downward, under the spine of the scapula—subspinous; and (4) forward, inward, and upward, under the clavicle—subclavicular.

A very rare form of shoulder-joint dislocation has been described, which is known as the *supracoracoid*. Another rare form is the *luxatio erecta*.

Subcoracoid Luxation.—The subcoracoid variety of dislocation embraces three-fourths of all the shoulder-joint luxations. It may be caused by direct force driving the head of the humerus forward and inward, or by indirect force, such as falls upon the hand or the elbow. In this dislocation the

head of the bone lies against the anterior surface of the scapular neck below the coracoid process. A part of the anatomical neck of the humerus lies upon the anterior margin of the glenoid cavity, and the head of the bone is above the tendon of the subscapularis muscle.

Subclavicular luxation is very rare. It is caused by the same sort of violence which produces subcoracoid luxation. The head of the bone rests upon the thorax, below the clavicle, and underneath the pectoralis major muscle.

Subglenoid or Axillary Luxation (Fig. 347).—May be produced by contraction of the great pectoral and latissimus dorsi muscles when the arm is at a right angle to the body, but it is usually due to falls upon the hand or the elbow when the arm is raised and the head of the bone is against the lower portion of the capsule. In this dislocation the head of the bone rests upon the border of the scapula, below the tendon of the subscapularis, in front of the long head of the triceps, and above the teres muscles. Some observers hold that most dislocations of the shoulder are primarily subglenoid, the position having been altered by muscular action. Luxatio erecta is an unusual form of subglenoid dislocation. The arm is upright and the forearm rests behind the occiput or on the top of the head, and the patient holds it there to avoid pain. Judd, Hulke, and Cleland have related cases.

Subspinous Luxation.—Is a rare injury. Pick met with this accident in a man who, while having his hands in his pockets, fell upon the front of the point of the shoulder. The head of the bone reposes beneath the scapular spine, between the infraspinatus and teres minor muscles.

Supracoracoid luxation is seldom encountered. The head of the humerus rests upon the coraco-acromial ligament or upon the acromion process, and the acromion or the coracoid is always fractured.

Luxatio Erecta.—In this injury the arm is markedly abducted and in some cases the elbow is actually raised above the patient's head. In such an injury the head of the bone has passed under the subscapularis muscle and also under

the teres major or the lower border of the great pectoral.

Symptoms of Dislocation of the Shoulder-joint.-Dislocation is diagnosticated by-(1) pain of a sickening character; (2) flattening of the shoulder, the head of the bone having ceased to bulge out the deltoid muscle; (3) apparent projection of the acromion through sinking in of the deltoid; (4) hollow beneath the acromion, over the empty glenoid cavity, and the bone missed from its normal habitat. This hollow may be easily appreciated by the finger, especially when the extremity is somewhat abducted; (5) rigidity (some movement is possible, in the direction especially of an existing deformity, but mobility is strictly limited and attempts at motion produce great pain); (6) Dugas's sign: the elbow cannot touch the side when the hand is placed upon the sound shoulder, and the hand cannot be placed upon the sound shoulder if the elbow is to the side (this is due to the rotundity of the chest. In a dislocation the head of the bone is already touching the chest, and the bone, being approximately straight, cannot touch it in two places at the same time. If the elbow can be placed against the chest with the hand on the sound shoulder, there cannot be dislocation; if it cannot be so placed, there must be dislocation); (7) finding the head of the bone in a new situation; (8) examining by means of the x-rays. Symptoms I to 5 inclusive may be grouped as Erichsen's list of signs. The form of dislocation is made out by a study of the direction of the axis of the limb, the existence and extent of lengthening or of shortening, and the situation of the head of the bone.

In a shoulder-joint dislocation the head of the bone may press upon the brachial plexus and produce pain and numbness, and occasionally traumatic neuritis or paralysis; sometimes pressure upon the axillary vein causes intense edema, and pressure upon the axillary artery diminishes or obliterates the pulse. The axillary vessels may be torn and the muscles may be lacerated badly. The capsule is torn and considerable blood is usually effused. Swelling is due first to hemorrhage, and secondly to inflammation. Partial dislocations sometimes, though rarely, occur. What is usually spoken of as "partial dislocation" or "subluxation" is a condition in which the head of the humerus passes forward under the coracoid because of rupture of the long head of the biceps or because this tendon slips out of its groove, the ligaments of the shoulder-joint being intact.

The following table from T. Pickering Pick's work on "Fractures and Dislocations" makes the above points clear:

	DIRECTION OF THE AXIS OF THE LIMB.	ALTERATION IN THE LENGTH OF THE LIMB.	PRESENCE OF THE HEAD OF THE BONE IN NEW SITUATION.
Subcoracoid.	The elbow is carried backward and slightly away from the side.	Very slight lengthening.	The head of the bone cannot easily be felt; it is found at the upper and inner part of the axilla.
Subglenoid.	The elbow is carried away from the trunk and slightly backward.	Very considerable lengthening.	The head of the bone can easily be felt in the axilla.
Subspinous.	The elbow is raised from the side and carried forward.	Lengthening intermediate in degree between the subglenoid and the subcoracoid.	
Subclavicular.	The elbow is carried outward and backward.	Shortening.	The head of the bone can readily be seen and be felt beneath the clavicle.

Diagnosis of Shoulder-joint Dislocation.—In fracture of the neck of the scapula the acromion is prominent, a hollow is detected below it, and a hard body is felt in the axilla; but the coracoid process descends with the head of the humerus, which it does not do in dislocation. Furthermore, in fracture there is mobility; in dislocation, rigidity. In fracture crepitus is present; in dislocation it is absent. In fracture the deformity is easily reduced, but it at once recurs; in dislocation the deformity is with difficulty reduced, but does not recur. In fracture the elbow can be made to touch the side when the hand is upon the sound shoulder; in dislocation it cannot be so manipulated. In fracture of the anatomical neck of the humerus deformity is slight; the head of the humerus is found in place, does not move when the shaft is rotated, and is not in line with the axis of the bone. Crepitus

exists in the fracture if impaction is absent. In paralysis of the deltoid muscle there is distinct flattening, but the bone is felt in place and there is no

rigidity. The x-rays are a great aid to diagnosis.

Treatment of Shoulder-joint Dislocation.—Reduction by manipulation is usually readily obtained in recent cases of shoulder-joint dislocation. If a simple trial without ether fails, an anesthetic should be administered. Ether is given, but not chloroform, for chloroform seems to be particularly dangerous to life when given to enable the surgeon to reduce a dislocation of the shoulder. Forward dislocations (subcoracoid, subclavicular, and axillary) are reduced by Kocher's method (Fig. 349). This method was introduced by Kocher in 1870 ("Sammlung klin. Vorträge," No. 83). Reduction by this method can frequently be effected without the aid of ether. The patient should be recumbent. Slowly but forcibly adduct the abducted elbow and get it finally against the side. At the same time it is drawn slightly backward. The forearm is flexed. If there is much muscular resistance, follow Keetley's advice, and not only bring the elbow to the side, but push it backward and inward toward the spine. Grasp the elbow with one hand, and the wrist with the other, and slowly make external rotation until the forearm points outward from the body. We thus carry the head of the humerus to the margin of the glenoid cavity. External rotation must be done slowly and gently. When we first try it there is much muscular resistance. If enough force is used to overcome the resistance the surgical neck of the bone may be broken. By gently and gradually persisting in external rotation the muscles are finally tired out. Next lift the elbow anteriorly as far forward as it will go, so as to bring the head of the humerus to the glenoid margin just opposite the capsular tear (Keetley). Then throw the bone into place by gradually swinging the forearm inward across to the other side of the chest, that is, by internal rotation. The formula is, flexion of the forearm, external rotation, lifting the elbow forward, internal rotation of the arm, and lowering the elbow. The motions to unlock the bone and start it to retrace the steps it took when emerging should be gentle, not forcible, slow, not sudden, and rigid muscles should be tired out and made to relax by steady traction upon them. Sudden and violent motions increase rigidity. Adduction stretches the upper portion of the capsule and presses the head against the glenoid. External rotation opens the tear in the capsule. Elevation relaxes the untorn part of the capsule and coracohumeral ligament and stretches the torn portion. On this fulcrum, the head, which is the end of a lever, is forced into place. If in trying Kocher's plan external rotation of the humerus does not take place, abandon the method, as persistence will fracture the humerus. Another method of manipulation is as follows: if the right shoulder is dislocated, the surgeon stands behind the patient (who is sitting erect); if the left shoulder is dislocated, he stands in front of the patient. The surgeon holds the forearm flexed upon the arm with his right hand and makes external traction and rotation, and with the fingers of his left hand he tries to force the bone into place.

In Henry H. Smith's method for forward dislocations the surgeon stands in front of the patient. If the left shoulder is dislocated, the surgeon grasps it with his left hand; if the right shoulder is dislocated, he grasps it with his

right hand, the thumb resting on the head of the bone. With his disengaged hand the surgeon grasps the elbow, abducts it, makes traction and external rotation, and suddenly sweeps the elbow inward, aiming it at the sternum, and tries with his thumb to push the bone into place. In subspinous luxations reduction may be effected if the surgeon stands behind the patient, makes abduction, traction, and internal rotation, sweeps the elbow inward toward the spine, and with the thumb aids the bone in its return into position. Raising the elbow far above the head and sweeping it inward will reduce some dislocations. As the head of the bone slips back a distinct jar is felt and a snap is heard, the motions of the joint are again obtainable, and with the hand on the opposite shoulder the elbow may be made to touch the side.

Reduction by Extension.—Before attempting the reduction of a dislocation of the shoulder-joint by extension, the patient should be anesthetized and placed upon a low bed or upon the floor. The surgeon then places



Fig. 349.—Kocher's method of reduction by manipulation; a, First movement, outward rotation; a, second movement, elevation of elbow; c, third movement, inward rotation and lowering of the elbow (Ceppi).

his foot, covered only by a stocking, in the axilla. Place the sole of the foot, not the heel, against the chest high up, the instep being made to touch the humerus and the heel the border of the shoulder-blade, a towel being first put into the axilla to rest the foot against (Fig. 350). If the left arm is dislocated, use the left foot, and vice versa. The elder Gross approved of making extension while sitting between the patient's limbs. Make steady extension, which will in many cases bring about the reduction. If it fails to cause reduction, bring the patient's arm across the chest and use the foot as the fulcrum of a lever. If the humerus is pretty firmly fixed in its abnormal position, make counter-extension with a foot in the axilla and make extension by fixing a clove-hitch (Fig. 351) above the elbow and fastening to it bands which go over one shoulder and under the other shoulder of the surgeon. The back may thus be used for extension, the hands being left free for manipulation (Allis's and Pick's plan). Lateral extension is used by some surgeons. The patient lies down, a large piece of canvas is split, the arm is passed through the split, and the body is thus fixed. The arm is pulled to a right angle with the body and traction is applied.

The late Prof. Joseph Pancoast favored Sir Astley Cooper's method of

placing the unanesthetized patient in a chair and using the knee as a fulcrum,



Fig. 350.—Reduction of shoulder-joint dislocation by the foot in the axilla (Cooper).

pushing the elbow to the side (Fig. 352). Brunus, in the thirteenth century, devised the method of upward extension. In applying this method the



Fig. 351.—Clove-hitch knot applied above the wrist. In dislocation of the shoulder this knot is put above the elbow (after Erichsen).

surgeon takes his place behind the patient, steadies the scapula with his hand, and carries the patient's arm upward and backward above his head, making extension and external rotation (Fig. 353). La Mothe's method is applied with the patient supine upon the floor. The surgeon places his foot upon the shoulder to make counter-extension, and makes extension as in Brunus's method. It is a useful expedient, when either of these plans is



Fig. 352.—Reduction of shoulderjoint dislocation by the knee in the axilla (Cooper).

applied, to have an assistant make the traction while the surgeon manipulates the head of the bone. Cock advises, when reduction fails, that an air-pad be placed in the axilla



Fig. 353.—Reduction of shoulder-joint dislocation by upward extension (Cooper).

and the arm be bound to the side—a method by which reduction will sometimes take place after two or three days.

Pulleys should not be used to pull the bone into place, as they develop a dangerous force. In a dislocation irreducible by ordinary force, antiseptic incision is safer and better than the pulleys. After incision try to restore the bone to place.

In reducing a dislocation the axillary artery or vein may be ruptured, fracture of the neck of the humerus may take place, injury to the brachial plexus may occur, or the soft parts may be badly damaged. After reducing a dislocation apply a Velpeau bandage, keep the shoulder immobile for one week, then make passive motion daily, reapplying the dressing after each séance. The patient may wear a sling alone during the third week, after which period he may use the arm. (For compound dislocations see page 668.)

Unreduced and Irreducible Dislocations of the Shoulder.—In some cases where we find there is considerable movement without pain we can, by manipulation and active motion, seek to increase the range of movement and usefulness of the new joint.

As a rule, in a youth or a middle-aged person we attempt bloodless reduction if we see the case by or before the ninetieth day after the accident. Give

ether, break up adhesions by forced flexion and extension, and try Kocher's method, and, if this fails, the other methods, but never use violent force. In reducing an old dislocation we may fracture the surgical neck of the humerus. I have seen this happen twice. proper treatment is incision and pulling the head into place with McBurney's hooks. In attempting reduction of an old dislocation the brachial plexus may be lacerated or one or both of the axillary vessels may be torn. If an axillary vessel



Fig. 354.-Dislocation of both bones of the forearm backward.

is torn, it must be at once exposed by incision. A large tear in either vessel requires a ligature about the vessel on each side of the tear. A small tear may be sutured (Keetley, in "Lancet," Jan. 23, 1904). Rather than use sufficient force to endanger the vessels in attempting to reduce an old dislocation, practise incision. In some cases after incision the head of the bone can be pulled into place. In other cases the head must be resected. After

reduction of an old dislocation immobilize for three weeks, and begin passive motion after seven days.



Fig. 355-Reduction of elbow-joint dislocation.

If a dislocation is complicated by a fracture of the humerus, try to pull the head of the bone opposite the joint. This may be possible if the two fragments are held partly together by a fair amount of periosteum and muscle, Traction is exerted upon the arm, and an attempt is made to manipulate the head into the socket (Allis's plan in the hip). McBurney incises, fixes a hook

in the scapula and a hook in the head of the humerus, pulls the head into place, and wires the fragments (Figs. 250, 251, 252). In an emergency gimlets may be used instead of the hooks. In some cases it is necessary to excise the head of the bone.

Habitual or Recurrent Dislocations.—Habitual or recurrent dislocation of the shoulder, following an original traumatic dislocation, results usually from a slight or trivial force. It usually takes place while the arm is in abduction, slight rotation frequently being necessary. In some cases rotation will produce a dislocation while the arm is near the side of the body. Little is known of the frequency with which these cases occur, but they are probably much more frequent than is generally supposed. The frequency of the recurrences in the individual cases varies widely. In some they occur more or less regularly every two or three years, while in others they have been known to take place daily and even several times a day. In most cases in the intervals between the recurrences the joint functionates normally without difficulty, although the patient fears abduction because of its influence in favoring a recurrence. In rare cases pain persists a long time after each dislocation, so that if the recurrences are frequent, the patient may be compelled to give up work.

Cause.—The essential cause is a relaxation of the capsule at the site of the original tear, due to the addition to the old or original portion of the capsule of a new or cicatricial portion bridging over the gap between the margins of the tear produced by the first dislocation. The failure of these margins to unite closely is due to the repeated emergence of the humeral head forcing them apart before union is complete. The defects in the head of the humerus which have been found at autopsy and operation have, probably, only a slight and secondary causal importance, while the fractures of the greater tuberosity of the humerus sometimes occurring in dislocations of the shoulder are probably not followed by recurrent dislocations.

Treatment.—Excisions of the head of the humerus have been abandoned. Capsulorrhaphy for the shortening of the relaxed anterior portion of the capsule has given excellent functional results. Dr. Dawbarn, of New York, did this operation in my clinic, upon a city fireman, and the result was a perfect success. The capsule may be exposed through the usual resection incision along the anterior margin of the deltoid. This may be modified by an additional incision outward at right angles to the first, and the insertion of the pectoralis major may be partially divided. T. Turner Thomas makes an axillary incision along the inner border of the coracobrachialis, passing between this muscle and the axillary vessels and nerves, and avoiding particularly the circumflex and musculocutaneous nerves. The subscapularis muscle is partially divided to give a freer exposure of the capsule. This route exposes the site of the original tear in the capsule by a small incision. It avoids division of the deltoid and gives dependent drainage if drainage is necessary.

The relaxed portion of the capsule may be shortened by taking up a reef with catgut or silk sutures, without opening and exploring the joint for loose pieces of bone; the capsule may be incised transversely to its longitudinal fibers and the margins of the incision overlapped; an oval piece may be excised and the edges united by sutures; or the margins of the original tear may be found and sutured together.

Dislocations of the Elbow-joint.—Dislocations of the elbow-joint are not infrequent, and they are commonest in children. Both bones or only one bone of the forearm may be dislocated, and the dislocation may be partial or complete.

Dislocation of Both Bones Backward.—The causes of backward dislocation of both bones of the forearm are falls upon the extended hand or twists inward of the ulna (Malgaigne). The coronoid process lodges in the olecranon fossa of the humerus.

Symptoms of Backward Dislocation.—In complete dislocation of both bones of the forearm the olecranon is very prominent (Fig. 354). The distance between the point of the olecranon and the apex of the inner condyle is notably greater than on the sound side; the forearm is flexed, supinated, and shortened; the lower end of the humerus projects in front of the joint, below the skin-crease; the head of the radius is found back of the outer condyle; and there are the general symptoms of dislocation. Fracture of the coronoid rarely occurs with backward dislocation, but if it does occur, there will be crepitus and mobility. Fracture at the base of the condyles is distinguished from dislocation of both bones of the forearm backward by the following points: in fracture there are found the ordinary symptoms; measurement from the



Fig. 356.-Forward dislocation of the radius.

conclyles to the styloid processes does not show shortening; there is no alteration of the normal relation between the olecranon process and the conclyles; and the projection in front of the joint is above the crease of the bend of the elbow.

Treatment of Backward Dislocation.—Reduction must be effected early in dislocation of both bones of the forearm, because it will soon become impossible, and an unreduced dislocation means a limb without the powers of flexion, pronation, and supination. The surgeon may place his knee in front of the elbow-joint, grasp the patient's wrist, press upon the radius and ulna with his knee, and bend the forearm with considerable force, the muscle pulling the bones into place (Sir Astley Cooper's plan). Forced flexion, traction, and extension may be tried (Fig. 355). Put the arm in Jones's position for two weeks, and make passive motion daily after the first few days.

Dislocation of Both Bones Forward.—The cause of forward dislocation of both bones of the forearm is a blow on the olecranon when the arm is flexed. It is an unusual accident.

Symptoms and Treatment.—The symptoms of forward dislocation of both bones of the forearm are—the forearm is flexed and lengthened; some slight

motion is possible; the olecranon is on a level with the condyles if unfractured hence its prominence is gone; the humeral condyles are felt posteriorly, and the radius and ulna are felt anteriorly. The *treatment* of this injury consists in early reduction, which is accomplished by means of forced flexion, extension, and pressure, placing the part in Jones's position for two weeks, and making passive motion daily after the first few days.

Lateral dislocation of both bones of the forearm is usually incomplete. Symptoms and Treatment of Outward Dislocation.—The symptoms of outward dislocation of both bones of the forearm are—the forearm is flexed, fixed, and pronated; the joint is widened; the head of the radius projects externally and has a depression above it; the inner condyle projects internally and has a depression below it; the olecranon is nearer than normal to the external condyle and further than normal from the internal condyle. Reduction is effected by extension of the forearm and pressure inward upon the head of the radius. Apply an ascending spiral reversed bandage of the forearm, a figure-of-eight bandage of the elbow-joint, and a sling. Make passive motion after a few days. The bandages must be worn for two weeks.

Symptoms and Treatment of Inward Dislocation.—In dislocation inward of both bones of the forearm the position of the forearm is the same as that in dislocation outward; the sigmoid cavity of the ulna projects internally, and the external condyle projects externally. Reduction is effected by extension of the forearm and pressure outward on the ulna, subsequent treatment being the same as that employed in the preceding form.

Dislocation of the ulna alone is very rare, and can take place only backward.

Symptoms and Treatment.—Dislocation of the ulna alone is indicated by the forearm being flexed and pronated. The head of the radius is found in place, and the olecranon projects posteriorly. The treatment of this injury is the same as that for dislocation of both bones.

Dislocation of the Radius Forward (Fig. 356).—Dislocation of the radius forward is the commonest form of dislocation of the elbow. This injury is caused by a fall upon the hand with the forearm in pronation and extension, or is produced by blows on the back of the joint; forced pronation alone will not cause it.

Symptoms and Treatment.—The symptoms in dislocation of the radius forward are—the forearm is midway between pronation and supination, and is semiflexed; attempts to increase flexion cause the radius to strike against the humerus with a distinct blow; the head of the radius is felt in front of the outer condyle and is missed from its proper abode. Reduction is effected by flexion over the knee, extension, and manipulation. The subsequent treatment is Jones's position and passive motion. Deformity is apt to recur after reduction, because of rupture of the orbicular ligament.

Dislocation of the radius backward is caused by falls on the hand or by blows on the front of the joint.

Symptoms and Treatment.—Backward dislocation of the radius is indicated by the forearm being slightly flexed and fixed in pronation, by some impairment of flexion and extension, and by the head of the radius being felt behind the outer condyle. Reduction is effected by flexion over the knee, extension, and manipulation, and the subsequent treatment is the same as that given for the preceding dislocation.

Dislocation of the radius outward is very rare. In this injury the head of the radius is distinctly felt. Reduction is effected by extension and pressure; the subsequent treatment is the same as that for the abovementioned dislocations.

Subluxation of the Head of the Radius.—This name is given to an injury which is very frequent in children between two and four years of age. It results from traction upon the hand or the forearm, and often arises when the nurse or the mother pulls upon a child's arm to save it from a fall or to lift it over a gutter. Some writers hold that pronation as well as extension is required to produce the injury; many surgeons claim that extension and adduction are the causative forces. Hutchinson asserts that supination may cause subluxation. Bardenheuer assigned falls as causes.

The symptoms are very characteristic. The history points to the injury. Pain, and often a click, may be felt in the wrist at the time of the accident. The arm hangs by the side, with the elbow-joint slightly flexed and the forearm midway between pronation and supination. Flexion to an angle of less than 60° and complete extension are resisted and are very painful, but movements between 60° and 130° are free and painless.\* The movements of the wristjoint are free and painless. The elbow-joint presents no deformity. Pressure over the head of the radius causes pain. Strong pronation is painful; strong supination is very painful, and there seems to be a mechanical obstacle to its performance. Forced supination develops a distinct click at the head of the radius, and causes pronation and supination to become natural and free from pain. The condition will be reproduced if the parts are not immobilized for a time. The nature of the lesion is not understood, and various conditions have been thought to exist by different observers. Among them may be mentioned the following: a slight anterior displacement of a head of the radius; a slight posterior displacement; locking of the tuberosity of the radius behind the inner edge of the ulna; dislocation of the triangular cartilage of the wrist; intracapsular fracture of the radial head; painful paralysis from nerve-injury; displacement by elongation, the return of the bone being prevented by collapse of the capsule; and the slipping up of the margin of the orbicular ligament over the rim of the head of the radius.

Treatment.—In order to reduce place the forearm at a right angle to the arm and make forcible supination. Apply an anterior angular splint, and have it worn for four or five days, or put the part in Jones's position for an equal period.

Dislocations of the wrist are very uncommon and are caused by falls upon the hand.

Backward Dislocation of the Wrist.—Symptoms.—The deformity in backward dislocation of the wrist (Fig. 357, A) resembles that of Colles's fracture (Fig. 357, B). The fingers are flexed, the wrist is bent backward, the radius projects on the front of the wrist, the carpus projects on the dorsal surface of the forearm, the relation of the styloid process of the radius to the

<sup>\*</sup>See the instructive article by W. W. Van Arsdale, in the Annals of Surgery, vol. ix. 1880.

styloid process of the ulna is unaltered (it is altered in Colles's fracture), there is rigidity, and crepitus is absent.

Forward dislocation of the wrist, which is very unusual, is caused by a fall upon the back of the hand.

Symptoms and Treatment.—In forward dislocation of the wrist the radius and ulna project posteriorly and the carpus projects in front. The treatment in both of these dislocations is reduction by extension and manipulation, the use of a Bond splint for ten days, and the employment of passive motion after five or six days.

Dislocation at the inferior radio-ulnar articulation, which is also very common, is caused by twists.

Symptoms and Treatment.—In jorward dislocation at the inferior radioulnar articulation the forearm is pronated, the space between the styloid processes is diminished, and the ulna forms a projection posteriorly. In backward dislocation the forearm is supinated, the space between the styloid processes is diminished, and the ulna projects in front. Reduction is accomplished by extension and manipulation. Two straight splints (as in fracture of both bones) are to be applied for four weeks, and passive motion is to be made in the third week.

Dislocation of Individual Carpal Bones.—Pick says there is one weak spot, which is "between the head of the os magnum and the scaphoid and semilunar bones," and the os magnum may be forced up. This lesion is called by some dislocation of the os magnum backward. Codman and Chase



Fig. 357.-Deformity in dislocation of the wrist backward (A) and in Colles's fracture (B) (Stimson).

("Annals of Surgery," March and June, 1905) regard the injury as really dislocation of the semilunar jorward, a dislocation which may be associated with fracture of the carpal scaphoid. The injury is caused by forcible overextension or by twisting of the wrist. According to Codman and Chase, the injury usually occurs in men between thirty and forty, results from violent force, produces severe pain immediately, and tenderness and ecchymosis quickly arise. On examination a silver-fork deformity is observed, the posterior projection being the os magnum, this projection being separated from the radius by a groove which marks the former situation of the dislocated semilunar. The dislocated bone is felt under the flexor tendons of the wrist, the palm seems shorter than its fellow, the fingers are partly flexed, active or passive motion causes pain, and the x-ray exhibits the dislocated bone ("Annals of Surgery," March and June, 1905).

Treatment.—According to Codman and Chase, recent dislocations (even after the fifth week) may be reduced by hyperextension followed by hyperflexion over "the thumbs of an assistant held firmly in the flexure of the wrist

or the semilunar" ("Annals of Surgery," March and June, 1905).

If bloodless reduction fails, the authors advise palmar incision and reduction, and if this fails, excision of the bone. If in excising the semilunar the scaphoid is found to be fractured, the proximal part of the entire scaphoid must also be removed.

Dislocations of metacarpal bones are uncommon. The first metacarpal bone is most liable to dislocation.

Symptoms and Treatment.—Dislocations of the metacarpal bones are obvious because of projection. The dislocations are reduced by extension and manipulation, a straight splint and large pad for the palm are applied (as in fracture of the metacarpus), and the splint is worn for three weeks.

Dislocations at the metacarpophalangeal articulations are uncommon. Backward dislocation is the most common. The cause is a fall upon the hand.

Symptoms and Treatment.—Dislocated metacarpophalangeal articulations are obvious. Reduction is easily effected by extension and manipulation, except in the case of the thumb. A splint must be worn for three weeks.

Dislocation of the Metacarpophalangeal Joint of the Thumb.—
In this dislocation the phalanx usually passes backward. In some cases the long flexor of the thumb gets to the ulnar side of the head of the metacarpal bone and hinders reduction (J. Hutchinson, Jr., in "Brit. Med. Jour.,"



Fig. 358.-Levis's splint for reducing dislocation of phalanges.



Fig. 359.-Levis's splint applied.

Jan. 15, 1898). The chief impediments to reduction, as demonstrated by Farabeuf, are the sesamoid bones and glenoid ligament, which accompany the base of the phalanx in the dislocation. It is not probable that the catching of the metacarpal bone between the two heads of the flexor brevis, which often happens is an important impediment.

happens, is an important impediment.

Symptoms.—The symptoms of backward dislocation are as follows: The base of the first phalanx rests upon the metacarpal bone; the head of the metacarpal bone projects forward and buttonholes the muscles of the thumb; the first phalanx of the thumb is strongly extended, and the terminal phalanx is semiflexed. The symptoms of jorward dislocation are as follows: The base of the first phalanx is felt in the palm, and the head of the metacarpal bone is felt posteriorly.

Treatment.—In treating backward dislocation of the metacarpophalangeal joint of the thumb reduction is difficult. Always give ether. Keetley's directions are to adduct the metacarpal bone into the palm (this relaxes the flexor muscles) and to have an assistant hold it; bend the thumb strongly back, extend, pull the thumb toward the fingers, and suddenly flex. To get a firm enough grasp for these manipulations use the apparatus of Charrière or of Levis (Figs. 358, 359). If the above maneuvers fail, incise freely on the dorsum and reduce. Tenotomy is seldom of service. After reduction of this dislocation a splint must be worn for three weeks. In forward dislocation reduction is easily effected by strong extension and forced flexion. A splint is to be worn for three weeks.

Dislocations of the phalanges may be complete or may be partial. They are commonest between the first and second phalanges.

Symptoms and Treatment.—Dislocations of the phalanges are obvious. In reducing such dislocations employ extension and manipulation. Use a splint for one week.

Dislocations of the Ribs and Costal Cartilages.-The ribs may be dislocated from the vertebræ. This accident is seldom uncomplicated, and cannot be differentiated from fracture. The diagnosis is rarely made, and the injury is treated as a fracture. The ribs may be dislocated from their cartilages, one or more ribs being displaced. The end of the rib forms an anterior projection, there is a depression over the cartilage, and crepitus is absent. Treatment is the same as that employed for fractured ribs. The costal cartilages may be displaced from the sternum, forming an anterior projection upon this bone. Reduction is brought about by placing the patient upon a table, with a sand pillow between the scapulæ, pushing back the shoulders and chest, and forcing the cartilage into place. The dressings are the same as those used in fractured sternum. The cartilages of the lower ribs (sixth, seventh, eighth, ninth, and tenth) may be separated. The inferior cartilage goes forward and can be felt. Pick states that reduction is brought about by causing the patient to hold the chest full of air while efforts are made to push the cartilage into place. The injury is dressed as are fractured ribs (page 548).

Dislocations of the Sternum.—In dislocations of the body of the sternum the manubrium is separated from the gladiolus. The injury is a rare one, is usually associated with fracture, and is most common in the young. It is due in most cases to violent direct force inflicted by a fall or heavy blow; it may be due to indirect force and arose in one case of acute tetanus. The symptoms and treatment are the same as those of fracture (page 550). Dislocation of the ensiform process is one of the rarest of injuries. It is usually due to direct force, but Polaillon reports a case caused

by tight lacing.

Pelvic dislocations are almost always complicated with fracture. A pubic bone can be dislocated by falls from a height or by applying violent force to the acetabula. The dislocation may be up or down, front or back, and it may damage the urethra or the bladder. The patient cannot stand; there are great pain and recognizable deformity. Treat by moulding the bones into place, by applying a pelvic belt, and by rest in bed for four weeks.

Dislocations of the sacro-iliac joint are produced by falls. Movement on the part of the patient is difficult or impossible; there is violent pain, and often paralysis (from pressure upon nerves). In dislocation backward there is apparent shortening of the leg, eversion of the foot exists, and the ilium moves posteriorly and upward. In dislocation forward the anterior superior iliac spine projects and the pelvis is broadened. Sacro-iliac dislocations are reduced by holding the pelvis firm and making extension with a pulley. The patient stays in bed for four weeks and wears a pelvic belt as in fracture.



Fig. 360.—Thyroid dislocation of the femur, eight weeks after the accident. Reduced by open section (Rugh).

Dislocations of the Femur (Hip-joint).—These injuries are not often encountered, as the hip-joint is very strong. They occur in young adults. In forcible extension the head of the femur presses against the capsule of the joint, but the capsule here is very thick, and certain muscles, the rectus, psoas, and iliacus, are pulled tight and serve to strengthen it. The head of the bone cannot go directly upward, because of the acetabulum (Edmund Owen). The weak point of the acetabular rim is below; the weak part of the capsule is also below; hence forced abduction is apt to push the head of the bone through the lower part of the capsule, a dislocation occurring primarily into the thyroid foramen. The signs of the dislocation depend upon the untorn

portion of the capsule. The anterior portion of the capsule, including the Y-ligament, usually escapes laceration. Vessels are rarely injured. Muscles are often torn. In some cases the sciatic nerve is lacerated, bruised, or caught up on the neck of the femur during the circumduction of attempted reduction. Four forms of hip-joint dislocation are usually described: (1) upward and backward, on the dorsum of the ilium; (2) backward, into the sciatic notch; (3) downward, into the obturator foramen; and (4) inward, on the pubes.

All dislocations are primarily inward or outward. From these initial positions the head may be shifted to any region about the socket within reach of the remnant of untorn capsule (Oscar H. Allis). Allis rejects the old

classification and suggests the following:

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Low thyroid,
Mid- "
High "

All present abduction and outward rotation.

Reversed thyroid:

Low dorsal,
Mid- "
High "

All present adduction and inward rotation.
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Dislocations upon the dorsum of the ilium comprise one-half of all hip-dislocations. They are caused by a fall or a blow when the limb is flexed and abducted (as in carrying a weight upon the shoulder), by a fall upon the knees or feet, by a weight striking the back while bending, etc. Allis says rotation inward is the chief element in their production. In these dislocations the head of the femur goes upward and backward, rests upon the ilium, and is always above the tendon of the obturator internus muscle. These dislocations are secondary to thyroid dislocation, muscular action shifting the bone from its initial seat of displacement.

Signs.-Dislocation on to the dorsum of the ilium is indicated by the following symptoms: the buttock appears flat and broad; the great trochanter is above Nélaton's line and is deeply placed; the head of the bone can be detected in its new situation; deep pressure in front of the joints finds a hollow; the leg is shortened by about two or three inches, as a rule; the fascia lata is relaxed; in some thin people the socket can be outlined; when the patient is recumbent the injured extremity can be brought to the perpendicular without flexing the leg (Allis); the knee is somewhat flexed; the thigh is slightly flexed, inwardly rotated, and adducted (Fig. 361) (this is shown by the fact that the axis of the thigh of the injured side, if prolonged, would pass through the lower third of the sound thigh); when the capsule is extensively lacerated there may be no adduction and may be eversion (Allis); the heel is raised, and the great toe of the foot of the injured side rests upon the front of the instep or the ankle of the sound side; rigidity exists; voluntary movement is impossible, though some passive motion is possible in the direction of the deformity (the deformity can be made more marked). If a patient is recumbent and the knees vertical, the foot of the sound extremity is free of the bed, but the foot of the injured extremity touches the bed (Allis's sign). Diagnosis.—Examine first without anesthesia, and then again while the patient is anesthetized. The x-rays are valuable in diagnosis. Dislocation is

distinguished from intracapsular fracture by noting the inversion, the great shortening, the absence of crepitus, the age of the subject, and the nature of the force. The nature of the force, the inversion, and the absence of crepitus mark the diagnosis from extracapsular fracture.

Treatment.—The chief obstacle to reduction in dislocation on to the dorsum of the ilium, Bigelow states, is the untorn portion of the capsule, especially the Y-ligament. The ilio-femoral, Y, or Bigelow's ligament resembles an inverted Y, arises from the anterior inferior spine of the ilium, is inserted into the anterior intertrochanteric line, and is incorporated into the front of the capsule. To reduce a dislocation this ligament must be relaxed by manipulation or be torn by extension. Manipulation makes the head of the bone retrace its steps over the same route it took in emerging. Give ether; place the patient supine upon a mattress on the floor; flex



Fig. 361.—Hip-joint dislocation on to the dorsum of the ilium (Cooper).

the leg on the thigh (to relax the hamstrings), flex the thigh on the pelvis; increase the adduction over the middle line; strongly abduct; perform external rotation and extension. This treatment may be summed up as flexion, adduction, external circumduction, and extension; or, as Pick puts it, "bend up, roll out, turn out, and extend." Allis's advice is to fix the pelvis to the floor, lift the head of the bone to the level of the socket, rotate outward by carrying the leg toward the pubis, and extend the femur. If extension and counterextension are employed, make extension in the axis of the dislocated limb and obtain counter-extension by a perineal band. The extension band is fastened to the thigh by a clove-hitch. After reduction put the patient to bed and use sand-bags (as in fracture of the hip) for four weeks. We may tie the knees together instead of using the sand-bags. Passive motion is made in the third week. The pulleys must not be used in reduction. They may inflict great or even fatal injury. If the surgeon fails to reduce the deformity, there are two courses open to him. He may let it alone. He may operate. If he lets it alone, the limb will become ankylosed, though probably useful. Allis thinks the dorsal region will be the best place to have it. If he determines to operate, he must recognize that tenotomy is useless. It is necessary to make a free incision in order to restore the

Dislocation into the Sciatic Notch.—In this dislocation the head of of the bone passes backward and a little upward, and rests upon the ischium at the margin of the sciatic notch (not in the notch), below the tendon of the obturator internus muscle. The causes are the same as those given for the previous dislocation.

Signs.—The signs in dislocation into the sciatic notch are like those of dislocation upon the dorsum of the ilium, but they are not so marked. There are flattening and broadening of the hip; ascent of the trochanter above Nélaton's line; shortening to the extent of an inch; relaxation of the fascia lata. If the knee of the injured side is vertical, the sole of the foot touches

the bed. Flexion, inward rotation, and adduction exist, but the axis of the femur of the injured side passes through the knee of the sound side, and the ball of the great toe of the injured side rests upon the great toe of the sound side (Fig. 362), Other symptoms are identical with those of dislocation



Fig. 362.—Hip-joint dislocation into the sciatic notch (Cooper).

upon the dorsum of the ilium, but are less pronounced. Allis's signs of this dislocation are of value: if, with the patient recumbent, the thighs are brought to a right angle with the body, shortening on the affected side is materially increased; if the dislocated thigh is extended, the back arches as in hip disease.

Diagnosis and Treatment.—The signs of dislocation into the sciatic notch are similar to, but are less marked than, those of dorsal dislocation, and, being a backward dislocation, the reduction and treatment are the same as for dislocation backward upon the dorsum of the ilium.

Dislocation Downward into the Obturator Foramen.—Downward dislocation is the primary position of most dislocations of the hip, the bone rarely remaining in the thyroid foramen, but usually mounting up as a result

of muscular action or of the initial violence. The cause is violent abduction

by falls or by stepping from a moving car.

Signs.—Dislocation downward into the obturator foramen is indicated by flattening of the hip; the head of the bone is felt in its new position and is missed from the acetabulum; rigidity exists; passive motion is only possible in the direction of deformity, and that to a slight extent; a hollow is noted over the great trochanter, which process is well below Nélaton's line and

nearer than normal to the middle line. The gluteal crease is lower than is the crease of the opposite side; there is lengthening to the extent of one to two inches; the body is bent forward by the traction upon the psoas and iliacus muscles, and is also deviated to the side, thus causing great apparent lengthening; the limb is advanced partially flexed and abducted, and the foot is pointed straight ahead or is a little everted (Fig. 363); when the patient is recumbent extension is impossible, the knees cannot be pushed together without great pain, and the abductor muscles are hard and rigid. Allis' sign is absent. Unreduced dislocations do well, the patient obtaining a very useful hip-joint (Sédillot).

Treatment.—In treating dislocation downward into the obturator foramen give ether and effect reduction, if possible, by manipulation, and, if this fails, by exten-



Fig. 363.—Hip-joint dislocation into the obturator or thyroid foramen (Cooper).

sion. To reduce by manipulation, flex the leg on the thigh and the thigh on the pelvis, and then perform, in the following order, abduction, internal circumduction, and extension. Allis's rule of reduction is as follows: fix the pelvis to the floor; pull the head of the femur outward and above the socket; fix the head; push the knee toward sound knee and extend the femur. If extension is made, make traction in the axis of the limb by means of muslin fastened around the thigh by a clove-hitch. Do not use pulleys; incise rather than use them.

Dislocation upon the pubis is a very uncommon accident. The head of the bone usually rests just internal to the anterior inferior spine of the ilium. The primary position of the bone is in the thyroid foramen; the pubic dislocation, when it occurs, is always secondary, and is due to the initial force and to muscular action.

Symptoms.—In pubic dislocation the head of the bone can be felt and seen in its new position; the hip is flattened; there is a hollow over the great trochanter, this process being found below the anterior superior spine of the ilium; there is shortening to the extent of an inch; the limb is in abduction with eversion (Fig. 364), and the knees cannot be approximated without great pain.

Treatment.—In the treatment of pubic dislocation give ether and employ manipulation as for thyroid dislocation. If this fails, employ extension. The limb is well abducted, extension made downward and backward, and the

head of the femur pulled outward "by a towel around the thigh, just beneath the groin" (Keetley). The aftertreatment is the same as that for the previous forms.

Anomalous Dislocations of the Hip.—In supraspinous dislocation the dislocation of the hip is backward, the head of the femur resting upon the ilium above or even anterior to the anterior superior spine. In ischial dislocation the dislocation is downward and backward, the head of the femur resting on the ischial tuberosity or in the lesser sciatic notch. Monteggia's dislocation is a supraspinous dislocation with eversion of the limb. In perineal dislocation the head of the femur is in the perineum. In suprapubic dislocation the head of the femur passes above the pubes. In subspinous dislocation the femoral head rests on the horizontal ramus of the pubes.



Fig. 364.—Dislocation on pubis (Cooper).

Dislocation with Catching up of the Sciatic Nerve during Reduction.

This accident causes severe pain. The leg is flexed on the thigh and the thigh is flexed on the pelvis. Allis tells us that the task of reduction is very unpromising. We must strive to put the neck of the femur in such a position that the nerve will "drop off," and yet often the nerve cannot drop off because it is held by adhesion to the injured muscles. Allis attempts reduction by the following plan:

1. Place the patient upon his back and redislocate the femur.

2. Extend the thigh.

3. Flex the leg on the thigh.

4. Turn the ankle out until the leg is horizontal (this causes the head of the bone to look downward).

5. \*\* Shake, shock, jar, adduct, and abduct," to disengage the nerve.

6. Rotate into socket without flexing the leg (without making the nerve tense).

7. If this fails, make an incision above the popliteal space, and draw the nerve out of the wound. Detach the head of the bone from its entanglement and rotate it into the socket.\*

\*Allis's views will be found in "An Inquiry into the Difficulties Encountered in the Reduction of Dislocations of the Hip." By Oscar H. Allis, M.D. This highly original and valuable treatise received the Samuel D. Gross prize of the Philadelphia Academy of Surgery in 1895.

Dislocation of the Head of the Femur with Fracture of the Shaft of the Bone.—We may incise and replace and wire the fragments. We may use McBurney's hooks as in the shoulder. We may be forced to do a resection of the head.

Allis maintains that it is possible to reduce it by manipulation. He states that the upper fragment is the entire lever, and the lower fragment "is only the agent through which we apply our force." The fragments are not completely separated, but are connected at one side by material which is "partly periosteal, partly tendinous, and partly muscular." This connecting material enables us to make traction upon the upper fragment, but does not allow "rotation, circumduction, and leverage through the agency of the lower fragment." Hence "the only agency at our command is traction." If the dislocation is inward (forward), draw the head outward and have an assistant make direct pressure upon the head of the bone. If this fails, the assistant holds the head of the bone to prevent its slipping into the thyroid depression, and the surgeon makes traction inward or inward and downward. If the dislocation is outward (backward), make traction directly upward to lift the head of the bone to the level of the socket, and try to place the head over the socket by traction obliquely upward and inward. During all these manipulations an assistant presses upon the trochanter to prevent the head of the bone slipping back. tion is now made downward and inward, and the tightened ligament drags the head of the bone into place.

Dislocations of the Knee.—These dislocations are rare. There are four forms—forward, backward, inward, and outward. They may be complete or incomplete; the commonest dislocations are lateral. The cause is violent force, such as a fall, or in jumping from a moving train, or in being caught

by the foot and dragged.

Dislocation Forward of the Knee-joint.—In the complete form of forward dislocation the deformity is obvious. The limb is usually extended, but it may be flexed. Much shortening exists; the condyles are felt posterior and below; the head of the tibia is felt anterior and above; the patella is movable and the quadriceps is lax; pressure of the condyles upon the contents of the popliteal space arrests the tibial pulse and causes edema and intense pain. In incomplete dislocation the symptoms are identical in kind, but are less pronounced.

Treatment,—Compound dislocation of the knee-joint often demands excision or amputation. In simple dislocation give ether, have one assistant extend the leg while another makes counter-extension on the thigh, and the surgeon pushes the bone into place. Reduction is easy because of ligamentous laceration. Place the limb on a double inclined plane, and combat inflammation by the usual methods (see Synovitis, page 625). Begin passive motion in the third week. The patient must wear a knee-support for months. If the popliteal vessels are much damaged, gangrene will supervene and amputation will be demanded.

Dislocation Backward of the Knee-joint.—In the complete form of knee-joint dislocation backward, displacement is not so great as in dislocation forward. The head of the tibia projects posteriorly and above, the femoral con dyles anteriorly and below; the leg is, as a rule, partly flexed, but it may be extended, and there is moderate shortening. In *incomplete* dislocation the symptoms are less marked.

Treatment.—The treatment of backward dislocation of the knee-joint is the same as for forward dislocation.

Dislocation Outward of the Knee-joint.—Is usually incomplete. The inner tuberosity of the tibia in outward dislocation lies upon the outer condyle of the femur (Pick); the inner condyle of the femur projects internally; the outer tibial tuberosity and fibular head project externally, the former having a depression below it, and the latter above it; the leg is semiflexed, but shortening is absent.

Dislocation Inward of the Knee-joint.—Is usually incomplete. The outer tuberosity of the tibia in inward dislocation lies upon the inner condyle of the



Fig. 365.-Old dislocation of the patella outward.

femur; the outer condyle of the femur forms an external prominence, and the inner tuberosity of the tibia forms an internal prominence. Pick cautions us not to mistake a separation of the lower femoral epiphysis for lateral dislocation (the former is reduced easily, the deformity tends to recur, and there is soft crepitus).

Treatment.—In treating lateral dislocation of the knee-joint, effect extension and counter-extension as in anteroposterior dislocations. The leg is moved from side to side and attempts are made at rotation. The after-treatment is the same as that for anteroposterior luxations.

Dislocations of the Patella.—Are usually acquired. There are thirty-five congenital cases on record (Bajardi). There are three forms: outward, inward, and edgewise. The so-called dislocation upward is in reality rupture of the ligamentum patellæ (page 732).

Dislocation outward (Fig. 365) may be due to muscular action or to direct force, and occurs during extension of the leg. It occasionally happens in a person with knock-knee. If dislocation is complete, the bone lies upon the external surface of the external condyle; if incomplete, the patella rests upon the anterior surface of the external condyle. The leg is extended, flexion is impossible, and attempts at flexion produce great agony. In the patient shown in Fig. 365, flexion became possible in an unreduced dislocation, but not until months after the accident. The knee is wider than normal. There is a hollow in front of the joint. The bone is felt in its new position.

Dislocation inward is very rare. The signs are like those of dislocation outward, except that the patella rests upon the inner condyle.

Treatment.—Give ether. Raise the body upon a bed-rest, and flex the thigh. Grasp the patella and depress the margin which is farthest from the center of the joint (Pick). The muscles pull the bone into place. Immobilize for three weeks, and then begin passive motion. Incision may be necessary in order to effect reduction.

Dislocation of the Patella Edgewise.—The patella rotates vertically, one edge resting between the condyles. As a rule, the outer border is in the intercondyloid notch (Pick). This condition is produced by direct force when the extremity is partly flexed. Twisting and muscular action have been assigned as causes. The condition is obvious at a glance.

Treatment.—Give ether. Pick recommends "sudden and forcible bending of the knee." In some cases the bone can be pushed into place, the limb being extended and flexed as in the reduction of a lateral dislocation.

In some cases incision will be necessary.

Dislocation of the Semilunar Cartilages of the Knee-joint (the Internal Derangement of Hey; Subluxation of the Knee-joint). The condition was described by Hey of Leeds in 1803. The interarticular cartilages of the knee-joint are attached in front of and behind the tibial spine, and the convexity of each cartilage is attached to the edge of the corresponding tibial tuberosity by means of the coronary ligament. The internal cartilage is fastened to the internal lateral ligament and has a moderate freedom of movement. The outer cartilage is not connected with the internal lateral ligament and is not freely movable. It has been stated that the outer cartilage is more frequently dislocated than the inner, but modern experience indicates that this is not true, and that the internal cartilage is the one most apt to suffer. In 17 cases operated upon by Barker, the internal cartilage was involved in every case ("Lancet," Jan. 4, 1902). Those persons whose occupations force them to pass considerable time upon their knees are predisposed to this accident (Annandale). The derangement of the cartilage is usually caused by a sudden external rotation of the tibia, while the knee-joint is in partial flexion; for instance, when the patient stumbles over an obstacle, the knee-joint being partially flexed, the tibia is twisted outward. When the joint is flexed, a normal cartilage moves backward, and when it is extended, moves forward again. When the cartilage is thrown out by the sudden eversion and flexion of the tibia, it is caught and does not move into place readily when the leg is extended. The tear takes place in the direction of the fibers of the cartilage.

Symptoms.—The indications of interarticular cartilage displacement are a sudden, violent, sickening pain in the knee, which may be so severe as to cause the patient to fall to the ground. The knee is in a position of fixed semiflexion. Further flexion is possible, but extension is impossible. In some cases the patient can voluntarily make further flexion; in others, the pain is so severe that he either cannot or will not do it; but increase of flexion can be obtained by passive motion. The joint is, however, blocked both to passive and to voluntary extension. Attempts at passive motion are productive of fierce pain. If either cartilage is displaced away from the tibial spine, a prominence may be found on one or the other side of the knee-joint. If the displacement takes place toward the tibial spine, a prominence may be found on one side of the ligament of the patella. Subluxation is rapidly followed by inflammation of the synovial membrane of the joint and of the cartilages themselves; and swelling quickly masks the projection of the

cartilage. This accident is frequently mistaken for the blocking of the joint by a floating cartilage; but a dislocated cartilage always remains in the same position, and a loose cartilage changes its position from time to time (Turner). Loose bodies in a joint produce pain of a shifting character, and interference with both flexion and extension, or with either flexion or extension in an irregular way (Cotterill). In regard to the diagnosis, Cotterill points out that in a sprain of the joint extension is not painful, but flexion is interfered with; whereas, in the dislocation of a cartilage of the joint, flexion is still possible, but extension cannot be carried out ("Lancet," Feb. 22, 1902).

Treatment.—I have used with satisfaction to reduce a displaced internal semilunar cartilage a method described by Henry W. Jacob ("Brit. Med. Jour.," March 7, 1908). It is not followed by severe synovitis unless the patient has walked or has made repeated efforts to reduce the displacement, and as it is a painless method ether is not required. Jacob describes it as follows:

"The patient lies on a bed or couch, the surgeon standing on the outer side of the limb affected, with his face toward the patient's foot; the patient then raises his leg off the couch in the semiflexed condition, the surgeon grasps the patient's leg in both hands, and using his own thigh as a fulcrum, by means of a steady pulling movement draws the patient's leg outward while the surgeon's thigh keeps the patient's femur in a fixed position; directly this movement is effected the patient must steadily extend the limb, and the displaced cartilage will probably go back with a slight click; if the first movement of extension is not successful the maneuver must be repeated without any hurry or unnecessary force, and after a few attempts the cartilage can usually be felt to slip in without pain or inconvenience."

In treating dislocation of a semilunar cartilage of the knee it is customary to give ether and reduce by forced flexion and external rotation. sion becomes possible if the cartilage is freed. During these maneuvers an assistant endeavors to push any projection of cartilage into place. After reduction apply a splint for two weeks and combat inflammation by proper remedies (see Synovitis); then begin passive motion. At the end of two weeks apply a firm knee-cap made of leather and let the patient get about on crutches. After a couple of weeks the crutches can be laid aside. As recurrence of the displacement is usual, the patient should wear a knee-cap during the day for many months. A partial tear may entirely heal when thus treated by rest and support; an extensive tear will not, although even in such cases a useful but somewhat stiff joint may be obtained. If it is found impossible to unlock the blocked joint, or if the tear is extensive and redislocation is prone to occur, an operation is advisable. The joint is opened and the loose cartilage is pushed into place and held by stitches or the loosened portion is excised.

Dislocations of the Fibula: Dislocation at the Superior Tibiofibular Articulation.—This injury is rare. The head of the fibula may go
forward or backward. The causes are direct force and violent adduction of
the foot with abduction of the knee (Bryant).

Symptoms.—After dislocation of the fibula the position is one of semiflexion of the knee, voluntary extension and flexion being impaired or lost. A distinct movable projection is readily noticed in front or behind, which is found to be continuous with the fibula. There is a depression over the normal position of the head of the fibula.

Treatment.—In treating dislocation of the fibula bend the knee to relax the biceps, and proceed to push the bone into place. Put a compress over the head of the fibula, apply a bandage, and put the limb on a double inclined plane for three weeks. At the end of this time put a lacing kneesupport upon the knee and let the patient up. Displacement being liable to recur, a knee-cap must be worn for a year.

Dislocations of the Ankle-joint.—These injuries are not unusual. Fracture is a frequent complication. There are five forms of ankle-joint

dislocation-outward, inward, forward, backward, and upward.

Lateral dislocations of the ankle-joint are either outward or inward, and may be complete or incomplete. In these dislocations the astragalus rotates. In incomplete dislocations "there is no great separation of the trochlear surface of the astragalus from the under surface of the tibia, but the outer or inner margin of this surface is brought into contact with the articular surface of the tibia, and the whole foot presents a lateral twist"

(Pick). The causes of these dislocations are twists of the joint.

Symptoms.—Incomplete outward dislocation of the ankle-joint is known as Pott's fracture (see page 620). Complete outward dislocation, in which the articular surface of the astragalus is completely displaced outward from the articular surface of the tibia, and which condition is associated with a fracture of the fibula and separation of the inferior tibiofibular articulation, is known as Dupuytren's fracture. In incomplete dislocation the foot goes outward and upward, the fibula is fractured, and the tibiofibular ligaments are torn off. In Dupuytren's fracture the ankle is broad, the inner malleolus projects and looks lower than natural, the outer malleolus ascends with the foot, the foot rotates outward, and crepitus can be detected. In inward dislocation which is associated with fracture of the inner malleolus there is inversion, the outer malleolus projects, and crepitus can be detected. In incomplete separation the symptoms are similar, but are not so marked.

Treatment.—In treating a case of dislocation of the ankle-joint the deformity is reduced by flexing the leg on the thigh and the thigh on the pelvis; an assistant makes counter-extension from the knee; the surgeon makes extension from the foot, and at the same time rocks the astragalus into place. Dupuytren's fracture is treated in the same manner as Pott's fracture (page 621). Dislocation inward is treated in a fracture-box for the same period as Pott's fracture.

Anteroposterior dislocations of the ankle-joint are rare. The cause is the catching of the foot in jumping or falling—direct violence. In dislocation forward the foot is lengthened, the heel is not conspicuous, the tibia and fibula project against the tendo Achillis, and the relation of the malleoli to the tarsus is altered. In incomplete dislocation the symptoms are similar, but less pronounced. In dislocation backward the foot is shortened, the tibia and fibula project in front, the heel is prominent, and the relation between the malleoli and the tarsus is altered. In incomplete dislocation the symptoms are similar, but less marked.

Treatment.—In anteroposterior dislocation of the ankle-joint, reduce as in lateral dislocations. Sometimes the tendo Achillis must be cut. Apply a plaster-of-Paris dressing, and let it be worn for two weeks; then begin passive motion, and let the patient wear side-splints for a week longer.

Dislocation upward of the ankle-joint, or Nélaton's dislocation, is

a very rare injury. The astragalus is wedged between the widely separated tibia and fibula. This dislocation is usually associated with fracture. The cause is a fall upon the feet from a great height.

Symptoms.—Upward dislocation of the ankle-joint is indicated by the widening of the ankle and by the flattening of the foot. The malleoli are nearly on a level with the plantar surface of the foot, and there is absolute rigidity.

Treatment.-In treating upward dislocation of the ankle-joint give ether, and try to reduce by powerful extension and counter-extension. Treat the injury afterward in the same manner as an anteroposterior luxation.

Dislocation of the Astragalus.—The astragalus may be displaced from the bones of the leg and at the same time be separated from the rest of the tarsus. The displacement may be forward, backward, outward, inward, or

Dislocation of the astragalus forward or backward is caused by falls

Symptoms.—In forward dislocation the astragalus projects strongly; there is shortening of the foot, and the malleoli approach the plantar aspect of the foot; the foot is deviated to one side or to the other, and there is absolute rigidity of the ankle-joint. In incomplete luxations the symptoms are similar, but less marked. This dislocation may be obliquely forward. In backward dislocation of the astragalus the foot is not deviated to either side; the astragalus projects between the malleoli and above the os calcis, and the tendo Achillis is stretched over the projection. Rigidity is absolute. This dislocation may be obliquely backward.

Lateral and Rotary Dislocations of the Astragalus.-Lateral dislocations of the astragalus are rare, are always compound, and are always associated with fracture. In rotary dislocation the astragalus remains in its normal habitat after rotating on its own axis, either horizontal or vertical. The causes of rotary dislocation are twists of the foot when it is at a right angle to the leg (Barwell). The symptoms of rotary dislocations are obscure. There is rigidity, but sometimes portions of the astragalus may be made out.

Treatment of Dislocations of the Astragalus.- In treating astragalus dislocation reduce under ether by flexing the knee to relax the gastrocnemius, extending the foot, and pushing the bone into place. It may be necessary to cut the tendo Achillis. After reduction put up the foot and leg in a plasterof-Paris dressing for two weeks, and then begin passive motion and apply side-splints, which are to be worn for one week more. If reduction fails, support the limb on splints, combat inflammation, and endeavor to bring about union between the dislocated bone and the tissues. Often, in unreduced dislocation, the skin sloughs over the projecting bone. Excision is demanded the moment sloughing is seen to be inevitable. Cases of compound dislocation of the astragalus require immediate excision.

Subastragaloid Dislocation.-This condition is a separation of the astragalus from the os calcis and scaphoid, without separation from the bones of the leg. Pick states that the usual classification for these dislocations is forward, backward, inward, and outward, but that the displacement is, as a rule, oblique, the foot passing backward and outward or backward and

inward. The cause is twisting.

Symptoms.—In subastragaloid dislocation the astragalus projects on the dorsum; the foot is everted in outward dislocation and inverted in inward dislocation; the relation of the malleoli to the astragalus is unaltered; the ankle-joint is not absolutely rigid; the foot "is shortened in front and is

elongated behind" (Pick).

Tredtment.—To treat subastragaloid dislocation make extension in the direction opposite to that of the displacement. In dislocation of the tarsus backward fix a bandage around the foot, on a level with the heads of the metatarsal bones, which bandage the surgeon ties around his shoulders. The surgeon puts one knee in front of the ankle and thus fixes the leg, raises himself up to make extension upon the tarsus, and moulds the bone into position. Tenotomy may be necessary. After reduction apply a plaster-of-Paris dressing and have it worn for three weeks. The ankle-joint, fortunately, is not involved, and stiffness of this articulation need not be apprehended. If reduction is impossible, take the same course as in luxations of the astragalus.

Dislocations of the other tarsal bones are very rare. Single bones may be dislocated, or the luxation may occur at the mediotarsal articulation.

Symptoms and Treatment.—Projection is an obvious symptom in dislocation of the other tarsal bones. The treatment is to reduce by extension and moulding, the part being put up in plaster-of-Paris dressing for two weeks.

Dislocations of the metatarsal bones are rare.

Symptoms and Treatment.—Shortening of the toes and projection of the dislocated bone are symptoms of dislocation of the metatarsal bones. To treat these dislocations reduce by extension under ether and put up in a plaster-of-Paris dressing for two weeks. If reduction fails, the functions of the foot will not be much impaired.

Dislocations of the phalanges are very rare. The first phalanx of

the big toe is the one most liable to dislocation.

Symptoms and Treatment.—Dislocations of the phalanges are obvious. The treatment is by reduction as in dislocations of the thumb. Immobilize for two weeks.

## OPERATIONS UPON BONES AND JOINTS.

Osteotomy.—By the term osteotomy the modern surgeon means literally the sectioning of a bone for the purpose of straightening a limb ankylosed



Fig. 366.-Adams's large saw.

in a bad position, correcting a bony deformity, or amending a vicious union of a fracture. In a linear osleotomy the bone is transversely or obliquely divided at one spot; in a cuneijorm osleotomy a wedge-shaped portion of

boxe is removed. The operation of osteotomy may be performed with a set (Fig. 366) or with an osteotome. The saw creates dust, draws much into the wound, and lacerates the tissues to a considerable degree. We surgeons prefer the chisel or the osteotome. The osteotome slopes does to a point from each side (Fig. 367); the chisel is straight on one and on the other is bevelled to a point.



Fig. 367. - Osteotome.



Fig. 368.-Rawhide mallet.

Osteotomy for Genu Valgum, or Knock-knee (Macewen's Operation, Fig. 369).—In this operation the instruments required are the scalpel, hemosaic forceps, osteotomes of several sizes, a mallet (Fig. 368), and a sand-lag strapped in an aseptic towel.

Operation.—The patient lies upon his back, being rolled a little toward to diseased side. The leg of the diseased side is partly flexed upon the thigh upon the pelvis, and the extremity is laid upon its outer

surface, the sand-bag being pushed between the extremity and the bed, opposite to the sized section. The flexion of the lase relaxes the popliteal



Fig phy-Ossessory of the right feme is a case of knock-kneer: A s, Epithwal for; C, section of Macres; h s, action of Ognor.

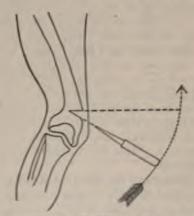


Fig. 370.—Macewen's operation for genu valgum. The chisel is held in the line for striking with a mallet; the arrow shows the direction in which the chisel is levered up and down so as to make a wide gap in the bone (after Barker).

vessels and saves them from injury. The surgeon, if operating on the right leg, stands outside of that extremity; if operating on the left leg, he stands opposite the left hip (Barker). The knife is inserted into the tissues and carried to the hone at the inner side of the knee, just in front of the adductor taberds of the inner condyle and on a level with the upper border of "the patcher articular surface of the femur" (Barker). An incision is made "patcher articular surface of the femur" (Barker). At incision is made "patcher articular surface of the femur of the axis of the femur. At the lower angle of this wound an osteotome is inserted and the blade after

insertion is turned to a right angle with the shaft of the femur, half an inch above the epiphysis (Fig. 369). The osteotome is struck several times with a mallet: the handle is moved several times toward and from the body, so as to widen the cut in the bone (Fig. 370); the osteotome is again struck with the mallet several times; it is again moved toward and from the body, and this process is continued until the bone is cut two-thirds through. If the osteotome becomes tightly fixed, it should be withdrawn and a smaller one introduced. In the soft bone of a young child this to-and-fro movement of the chisel, if carefully executed, is not liable to break the instrument. In dense bone it may break the instrument; hence, when doing an osteotomy in dense bone, the osteotome is moved to and fro across the limb and slight downward pressure upon the handle will to a great extent prevent binding. When the bone is cut two-thirds through, the osteotome is withdrawn, a piece of wet antiseptic gauze is held over the wound, and the surgeon fractures the femur by strong adduction. The wound is neither sutured nor drained. but is dressed antiseptically, the entire extremity is wrapped in cotton, and a plaster-of-Paris dressing is applied and carried up to the groin. The dressing may be removed in two weeks, and the patient may subsequently be treated with sand-bags, as for an ordinary fracture of the thigh, but without extension. This operation is scarcely ever fatal.

Ogston's Operation (Fig. 369).—In this operation the internal condyle is sawed off obliquely with an Adams saw—a proceeding which permits the straightening of the knee. The objection to the procedure is that it opens the knee-joint, and that this cavity fills up more or less with a mixture of blood and bone-dust. Macewen's operation is decidedly the safer.

Osteotomy for a Bent Tibia.—In this operation the instruments required are the same as those used in the above operation. The tibia is divided transversely or obliquely (linear osteotomy), or a wedge-shaped piece is removed (cuneiform osteotomy). The oblique incision is the best. If the convexity of the tibial curve is inward, cut the bone from above downward and from in front backward; if the curve is forward, section the bone from above downward and from within outward. The fibula need rarely be interfered with. After the osteotomy the limb is treated just as it would be for a fracture.

Osteotomy for Faulty Ankylosis of the Hip-joint.—This operation is performed in order to allow straightening of a limb that has undergone bony ankylosis in a faulty or an inconvenient position. In some cases an attempt is made to obtain a movable joint, but in most cases the surgeon must be satisfied with an ankylosis in extension. Osteotomy may be performed through the neck of the femur or through the shaft of the femur below the trochanters.

Osteotomy through the neck of the femur is performed (1) with a saw (Adams's operation) or (2) with an osteotome.

1. Adams's Operation (Fig. 371).—In this operation the instruments required are a scalpel, hemostatic forceps, a long, blunt-pointed tenotome, and an Adams saw.

Operation.—The patient lies upon his sound hip; the surgeon stands upon the side to be operated upon, and back of the patient. The knife is entered a finger's breadth above the great trochanter, is pushed in until it strikes

the neck of the bone, is then carried across the front of and at a right angle with the neck, and is withdrawn, enlarging the wound, in the soft parts as it emerges, to the extent of an inch. The saw is then introduced and the neck of the femur is entirely divided. After the osteotomy dress the wound antiseptically and place the extremity straight. To straighten the limb it may be found necessary to cut contracted tendons and fascial bands. After securing extension and applying dressings use the weight-extension apparatus and the sand-bags. Begin passive movements from the start if a movable joint is desired; few patients can tolerate the pain necessary to bring this about. If it is determined to aim for a stiff joint, treat the case as an intracapsular fracture would be treated.

2. With an Osteotome.—The instruments required in this operation are the same as those used for genu valgum. A sand-bag is not needed. The position of the patient is the same as that in Adams's operation. An incision one inch long is made, starting just above the great trochanter, ascending in the axis of the femoral neck, and reaching to the bone. An osteotome

is introduced, is turned to a right angle with the neck of the bone, and is struck with a mallet until the bone is completely divided. (It is not to be divided partially and then broken.) The after-treatment is the same as that for Adams's operation. The operation with the osteotome is to be preferred to that by the saw.

Osteotomy of the Shaft of the Femur below the Trochanters (Gant's Operation).—In this operation (Fig. 371) the saw may be used, but the osteotome is to be preferred. The instruments employed are the same as those used for Adams's operation, plus an osteotome.

Operation.—The position in Gant's is like that in Adams's operation. A longitudinal incision one inch long is made upon the outer aspect of the femur and on a level with the lesser trochanter. The osteotome is inserted, and the bone is completely divided below the



Fig. 371. — Osteotomy through the neck of the femur: A, Adams's operation; B, Gant's operation.

lesser trochanter. The after-treatment is the same as that for Adams's operation. Gant's operation is the best method for correcting faulty position in bony ankylosis, and Adams's operation can only be employed in those cases where the femur still has a neck which is practically unchanged.

Osteotomy for Faulty Ankylosis of the Knee-joint.—This operation performed for bony ankylosis of a knee in a position of flexion. The instruments employed are the same as those used for genu valgum.

Operation.—The patient lies upon his back with his thighs flat upon the bed, the legs hanging over the end of the bed. The surgeon stands on the patient's right side. Just above the patellar articular surface upon the femur a transverse incision is made, one inch in length and reaching to the bone. The osteotome is introduced and the bone is cut nearly through. The leg is then forcibly extended. It must not be extended too violently, or the popliteal vessels may be injured. In cases where the structures of the popliteal space are tense, the leg must not be brought at once into extension, but this position should be attained gradually by means of weights. The

wound is dressed aseptically, and the extremity is placed upon a double inclined plane and is treated as for fracture near the knee-joint.

Osteotomy for vicious union of a fracture is performed in case of angular deformity, and is carried out in the same manner as are the above procedures. It is best, when possible, to enter the osteotome upon the concavity of the bent bone, so that the periosteum will not rupture when extension is made, and the patient will in consequence gain a longer limb.

Osteotomy for Hallux Valgus.—In this operation a linear osteotomy is made through the neck of the metatarsal bone of the great toe, the toe is forcibly adducted, and a splint is applied to the inside of the foot and the

toe.

Osteotomy for Talipes Equinovarus.—The instruments required in this operation are a scalpel, hemostatic forceps, a narrow, blunt-pointed saw, special directors, bone-cutting forceps, sequestrum forceps, and scissors.

Operation (after Barker).—The patient lies upon his back, the thigh is semiflexed, the knee is bent, and the sole of the foot rests upon the table. The surgeon stands to the right side if it is the right limb which is to be operated upon, or to the left side if it is the left limb. The surgeon feels for the outer surface of the cuboid bone, and cuts away from over the latter a piece of skin corresponding in size with the bone-wedge intended to be



Fig. 372.- Davy's director (Pye).

removed (this piece of skin must include the bursa which forms in these cases). The foot is then turned outward, the astragaloscaphoid articulation is located, and over this an incision is made "from the lower to the upper dorsal border of the scaphoid bone" (Barker), reaching through the skin only; the foot is placed

again in the first position, all the soft parts are raised from off the superior surface of the tarsus, and a triangular surface corresponding with the base of the wedge to be removed is cleared; a "kite-shaped" director (Fig. 372) is passed into the external wound and projected from the internal wound; the saw is pushed through the groove of the director nearest the toes, and is made to cut through the tarsus, from the dorsum to the sole, at right angles to the metatarsal bones; the saw is pushed through the groove of the director nearest the ankle, and is made to cut from the dorsum to the sole, at right angles to the long axis of the calcaneum; the wedge-shaped piece of bone is grasped with sequestrum forceps and cut out with scissors, with bone forceps, or with a blunt bistoury. The wound is well irrigated, the foot is straightened, the internal wound is sewed up, the external wound is sutured except at its lowest portion, where a drainage-tube is to be retained for twenty-four hours, and the wound is dressed antiseptically. The foot is put up in plaster or upon a Davy splint.

Osteotomy for Talipes Equinus.—This operation is described by Mr. Davy, who devised it, as follows:\* "Taking the line of the transverse tarsal joint as a guide, on the outer and inner sides of the foot, and immediately over the joint, two wedge-shaped pieces of skin are removed, equal in extent to the amount of bone demanded. The soft structures are freed on the dorsum of the foot in the way previously described; but, as the base of the

\* Barker's "Manual of Surgical Operations,"

osseous wedge for equinus cases is at the dorsum and its apex at the sole, the parallel wire director, instead of the kite-shaped varus one, is used. The saw is successively inserted in its grooves, and by keeping in mind the idea of a keystone a clean wedge of bone is cut out from the dorsum to the sole of the foot." The wedge is extracted, and the foot is straightened and is

put up in plaster of Paris or is placed on a Davy splint.

Operative Treatment of Recent Fractures.-We have learned from skiagraphs that the common treatment by splints usually results in more or less permanent displacement. In many cases this does not interfere with function; in some cases it does. There is much impairment of function after a fracture of the patella with wide separation of the fragments, and after a fracture of a long bone with marked angulation or with decided overlapping of the fragments. The most perfect results are obtained by operation, exposure of the fragments, correction of deformity, while we see the fragments and fixation. Practically all surgeons agree that for fracture of the patella and for fracture of the olecranon treatment by operation gives the best results. All compound fractures require operation. In a fracture of a long bone with incomplete reduction or with a deformity which recurs in spite of splinting, operation should be performed. In most fractures of long bones perfect apposition of the fragments is not obtained, although we may think it has been. The x-rays illustrate the error and we often find it on incision. Bloodgood points out that in fractures near joints there is great difficulty in reduction and little evidence of deformity. Oblique fractures of the upper third of the femur should be operated upon because of the difficulty or impossibility of reduction by any other method.

In some cases of fracture of the bones of the forearm operation is indicated to preserve pronation and supination. If the ends of the fragments do not grate when they are apparently in contact and are rubbed to and fro, it means that some of the soft parts are caught between them and operation is necessary in order to remove the intervening tissue. If this is not done there will be non-union or delayed union. Many comminuted fractures should be treated directly after incision of the soft parts. If an important nerve or blood-vessel has been divided, operation is required for that reason. During the operation the seat of fracture should be exposed and the fragments fixed. In a fracture of the neck of the femur in a youth or a person of middle age the fragments should be nailed together, otherwise there will probably be much lameness. Many fractures of the clavicle should be exposed by incision and wired. This should always be done when sharp ends endanger or have wounded vessels.

Some cases of fracture of the humerus near the elbow and some cases of fracture of the surgical neck of that bone require operation. Most cases of fracture with dislocation require it.

In any case of fracture, if it seems that non-operative treatment will fail to give a good functional result, operation should be advised if it is not contra-indicated by the condition of the patient.

There is, of course, some risk in treatment by incision and it is only justifiable in competent hands and amid proper surroundings. It can never be routine treatment and will never be extensively employed outside of a hospital. The occasional operator should look to it with less confidence than does

the daily operator. If infection should occur it will be a catastrophe and may cause death, hence, perfect asepsis is imperatively required.

Bone fragments may be held together by wire, nails, screws, plates, bone ferrules, chromic catgut, clamps, etc., according to the needs of the case. As a general thing silver wire is used, but it has defects. It fails to retain fragments in rigid apposition and unless very thick wire is used it is liable to break. Silver wire was used for this purpose in 1775 by Lapeyode and Sicre of Toulouse (Geo. W. Guthrie, "Amer. Medicine," March 7, 1903). In most cases I prefer the silver plate perforated for short silver screws as employed by Prof. Halsted. This gives rigid fixation and the screws do not project from the wound. The plate is not removed unless it causes trouble.

After operation there must be careful fixation by splints or plaster of Paris, the circulation must be guarded and maintained, massage should be used, and passive movements instituted as in a case treated without incision.

If rigid fixation of the fragments was secured, repair takes place with very little callous formation.

Recent Transverse Fracture of the Patella.—(See page 612.) Bone-grafting, or Transplantation.—(See page 508.)

Operative Treatment of Ununited Fracture.—The instruments required in this operation are a scalpel, hemostatic forceps, dissecting forceps,



Fig. 374-Brainard's drills with Wyeth's adjustable handles.

retractors, Allis's dissector, an awl or special drill (Figs. 373, 374), chisels, a mallet, a fine saw, lion-jaw forceps, and silver wire.

In operating, incise longitudinally down to the seat of fracture, retract the periosteum from the bone, drill the bones before cutting them, chisel away the material of imperfect union, saw through each bone end far enough from the seat of fracture to reach sound tissue, pass large silver wires through the holes (this wire should be one-tenth inch in diameter for the femur, one-sixteenth inch for the patella, etc.) (Fig. 377), twist the wires a fixed number of times (two complete turns) in the direction that the hands of a watch move (this is Keen's direction. In case removal of the wires should be demanded later we know how to untwist them), sever the ends of the wires, and hammer their stems against the bones. The wires may never require removal. Dress the part as a recent fracture. Various plans besides wiring have been employed in ununited fracture. Gussenbauer's

clamp is used by some. Clayton Parkhill's bone-clamp is a very useful appliance, and holds the fragments firmly in contact (Fig. 255). Menard and Lannelongue inject a 1:10 solution of chlorid of zinc between the fragments and around their ends, and then immobilize the parts. Some surgeons unite the fragments with kangaroo-tendon instead of wire (suturing of bone); others use nails of bone or ivory; others use screws. Senn asserts that the above methods will not hold fragments in contact if these fragments have a tendency to become displaced. Senn fastens the bones together by hollow cylinders of decalcified bone or ivory, the cylinders being perforated in many places (bone ferrules). The soft parts are sutured, no drain is used, and the limb is encased in plaster of Paris.

Ununited Fractures of the Femoral Neck.—Loreta did the first successful operation for this condition about seventeen or eighteen years ago. The operation is not adapted to the aged, but should certainly be employed in youths and middle-aged individuals if the general condition of the patient or

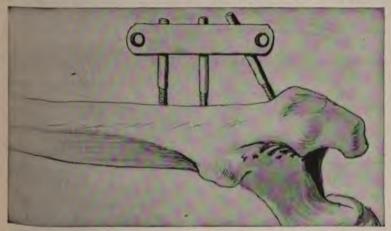


Fig. 375.—Method of securing screw of Freeman's apparatus in fracture of neck of femur; the wooden plates embracing screws (Freeman, in "Annals of Surgery," Oct., 1904).

some particular diseased state does not forbid, and if pain is severe and disability is pronounced.

Leonard Freeman advises an anterior incision beginning below and external to the anterior superior iliac spine and extending downward, external to the sartorius, for 3 or 4 inches ("Annals of Surg.," Oct., 1904). When the fragments are exposed, the connective tissue between them is cut away by means of scissors, the surfaces of the fragments are freshened with a chisel or acuret, oozing is arrested by pressure and hot water, and loose osseous splinters are removed (Freeman). Some surgeons have fixed the fragments together by nails, screws, or pegs of bone or ivory, access to the trochanter being best obtained for this purpose by making a second incision over the outer portion of the bony process. As Freeman points out, however, the head is often so very soft that none of these appliances will obtain fixation.

Freeman has devised a clamp for this purpose (Figs. 375, 376). An additional incision is made over the trochanter and holes are bored for the clamp

screws, one hole being drilled "through the base of the trochanter, the external fragment of the neck, and into the head of the bone" ("Annals of Surgery," Oct., 1904). The wound is closed, dressings are applied, and extension is made on a long side splint, a pad being placed beneath the trochanter to prevent the disposition to pass backward, which movement, if it occurs, will cause external rotation of the limb and separation of the fragments. In about eight weeks the extension is removed and the patient is allowed about on crutches. Dr. H. Augustus Wilson has succeeded by nailing the fragments together. He gets such a patient up on crutches in two weeks ("Amer. Jour. Orthopædic Surgery," Jan., 1908).

In Freeman's case the screws were removed in two weeks because of infection of the cancellous tissue. A similar condition arose in Davis's case in

which two steel drills were used.

According to Freeman, 14 operations for ununited fracture of the femoral neck are on record ("Annals of Surgery," Oct., 1904). Four of these cases were done by G. G. Davis. Cobb finds six additional cases and reports one of his own (Farrar Cobb, in "Boston Med. and Surg. Jour.," May 10, 1906). Dr. H. Augustus Wilson has collected 36 cases of direct fixation of old intracapsular fractures ("Amer. Jour. Orthopædic Surg.," Jan., 1908).

Ununited Fracture of Patella .- An incision is made in the long axis of

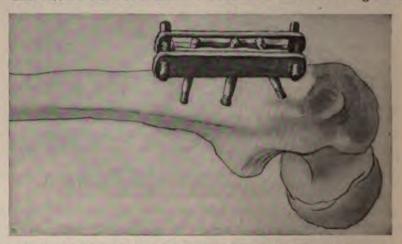


Fig. 376.—Completed screw and clamp of Freeman's apparatus for fixation of fracture of neck of femur (Freeman, in "Annals of Surgery," Oct., 1904).

the limb, over the middle of the space between the fragments, from well above the upper fragments to well below the lower piece; this incision divides all the soft parts. The soft parts are retracted, but the periosteum is undisturbed; each fragment is bored (Fig. 378, 1) in one or two places; the surfaces of the fragments are cut square through sound bone with a saw; all old reparative material is cut away; the wires are passed through the perforations, twisted, cut off, and hammered down (Fig. 378, 2). If the bone fragments cannot be approximated, it may become necessary to incise the muscle around and above the patella or partially to separate the tuberosity of the tibia and bend this process upward. A small drain is inserted above the bone, the wound is sutured, aseptic dressings are applied, and the limb is put upon a Macewen splint.

Treves's Operation for Caries of the Lumbar and Last Dorsal Vertebræ.—The instruments required are a scalpel, hemostatic forceps, grooved director, an Allis dissector, sequestrum forceps, curet spoons, and a sand-bag. We will describe the operation as performed on the right loin.

Operation.—The patient lies upon his left side, with the knees drawn up and a sand-bag under the left loin. The surgeon stands behind the patient (Barker). An incision is made at the outer border of the erector spinæ mass, reaching from the last rib to the iliac crest and going down at once to the lumbar fascia. The lumbar aponeurosis is opened, the erector spinæ muscle is re-

tracted inward, and the anterior portion of the erector spinæ sheath is incised. The quadratus lumborum muscle is next cut, and then the anterior leaflet of the lumbar aponeurosis is slit. The abscess is thus reached and opened and tuberculous pus flows out. The cavity is carefully irrigated. The abscess cavity is irrigated with quantities of warm corrosive sublimate solution (1:5000). The cavity is filled, the fluid is allowed to flow out, its exit being aided by pressure in front and changes of posture; the cavity is filled again, and so on, and, after all loose débris

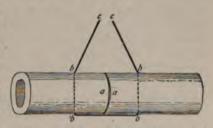


Fig. 377.—Wiring of bones for ununited fracture: a a, Sawn surfaces approximated after removal of old material which was interposed between the fragments; b b, b b, perforations drilled completely across the bone; c, c, wires ready for twisting.

is removed, the bodies of the vertebræ are carefully examined with the finger and diverticula are opened. Loose pieces of bone are removed with spoons or forceps, and cavities are thoroughly but lightly cureted, as in some places the wall is very thin. By means of properly shaped spoons

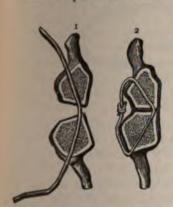


Fig. 378.—Wiring of the patella:

1. Fraggreeuts cut and cleaned and
the wares passed; 2, wires twisted
and harmmered down upon the bone
(after Barker).

carious bone can be removed even from the anterior surface of the column (Treves). Thus the wall of the abscess is completely removed. Finally all débris is washed out by irrigation with mercurial solution; any mercurial solution which might remain is washed out with warm water or salt solution, and the interior of the cavity is wiped dry. At this stage most operators introduce iodoform emulsion. Whether or not this is done, "the wound is closed by a series of silkworm-gut sutures, passed sufficiently deep to include the greater part of the muscular and tendinous structures with the skin" (Treves's "Operative Surgery").

Aspiration of Joints.—In certain cases of joint-effusion from inflammation, tuberculous or otherwise, and sometimes in hemorrhage into a joint, it is desirable to re-

move the fluid by aspiration. The pneumatic aspirator is used (Fig. 379). The trocar and cannula are thoroughly asepticized and the joint is prepared as for a set operation. The needle is entered at a surface

free from vessels. The directions for using an aspirator are as follows: insert the stopper firmly into a strong bottle (preferably a clear glass one), then attach the short elastic hose to the stopcock B of the tube projecting from the stopper, and attach the other end of the same elastic hose to the exhausting or inward-flowing chamber of the pump. Next attach one end of the longer elastic hose to the stopcock A projecting from the stopper and the other end to the needle. Care should be taken that all the fittings or attachments are placed firmly into their respective places. Now close the stopcock A and open the stopcock B. By giving from thirty-five to fifty strokes of the pump a sufficient vacuum can be produced to fill with the fluid from the joint a bottle holding from a pint to a quart. After having formed the vacuum, close the stopcock B, and insert the needle in the joint. When the stopcock A is opened, suction through the needle draws the fluid from the joint. The trocar may also be used to inject antiseptic agents. After the completion of aspiration the part is dressed antiseptically and the extremity is put at rest upon a splint.

Excisions of Bones and Joints.—The ancients practised excision and resection for compound dislocations and fractures. The operation was first formally advised as a substitute for amputation in joint disease by Mr.



Fig. 379.—Aspirator and injector.

Park in 1782. The terms excision and resection are usually employed as synonymous, but such a use is not strictly accurate. According to Professor Ashhurst, the term excision means "the removal of an offending part without that total ablation of the affected portion of the body which is implied by the term amputation. Hence we speak of excisions of tumors, of joints, of the eyeball, etc." Resection has a more restricted meaning; it signifies "an operation which takes away a middle portion and brings the ends together again, and is thus in strict surgical language limited to partial excisions of the long bones" (International Encyclop. of Surgery, edited by John Ashhurst, Jr.). Excision of a joint is the removal of the articular portions of the bones of the joint, and also the cartilage and synovial membrane. In the hip-joint and shoulder-joint only the head of the long bone may be removed, and not the articular surfaces of both bones. In partial excision of a long bone excision (resection) for bone disease enough bone is known to have

been removed only when the remaining bone bleeds. Complete excision of a bone is the removal of an entire bone. Partial excision or resection is the removal of a portion only of a bone. Excision is a conservative operation

which often averts amputation.

Excision may be performed by the open method, in which the periosteum is not preserved, or it may be performed by the subperiosteal method, in which the periosteum is carefully separated by a rugine and the capsular ligament is preserved. Arthrectomy, or erasion, is the excision of the diseased synovial membrane and ligament, and also small foci of disease of bone and cartilage.

Excision may be employed for compound dislocation, and in compound dislocations of the elbow and the shoulder it is usually performed. Excisions for compound dislocations in other large joints are very dangerous; they are rarely attempted in battle-field practice, and are to be avoided even in civil practice unless the patient is young and vigorous and every advantage can be given him during the operation and convalescence. Excision for deformity is rarely performed except upon the hip, the knee, and the shoulder, and these excisions must not be employed if the patient's condition leads one to fear the result of a protracted convalescence. Excision of the elbow, however, is usually a safe operation. In excising for deformity always consider the patient's trade and the demands of habitual position which it makes upon him.\*

Excision is largely employed for joint-disease, especially for tuberculous joints. Bell states that attempts to preserve the limb without excision are more justifiable in the lower than in the upper limbs, because operation in the lower extremity is more dangerous than in the upper, and because a cure without operation in the lower limbs, if this cure can be brought about, gives as good a result as a cure by excision. In the upper extremities the danger from operation is less than is the danger from waiting. In a young subject an excision may remove the epiphysis, and thus lead to permanent shortening, which is productive of less inconvenience and deformity in the arm than in the leg. The great danger of excision operations is that the section may be made through cancellous bony tissue; hence disastrous suppuration, phlebitis, myelitis, septicemia, or pyemia may follow; further, in excision the cut is often made through diseased tissue, and a protracted convalescence is often inevitable. Amputation is effected through healthy tissue, and the convalescence is short. Excision, however, when successful, gives the patient a very useful limb.

Erasion, or Arthrectomy.—Erasion is the complete removal of diseased synovial membrane, ligaments, etc. This operation seeks to remove a depot of infection in an early stage of tuberculous synovitis, and it possesses the conspicuous merit of not interfering with the epiphysis. The term erasion is also used to designate the operation of removing healthy synovial membrane, ligaments, etc., for the purpose of producing fixation of a flail joint due to infantile paralysis. Erasion is oftenest practised upon the kneejoint. The instruments required are a scalpel, hemostatic forceps, dissecting forceps, toothed forceps, volsellum, scissors, bone-gouges, curets, and an Esmarch apparatus.

Erasion of the Knee-joint .- The patient lies upon his back; the leg is

<sup>\*</sup> Joseph Bell, in his "Manual of Surgical Operations."

flexed with the sole of the foot planted upon the table, and an Esmarch bandage is applied at a point well up on the thigh. The surgeon stands to the right of the patient. The incision is begun in the mid-line of the thigh (on the side opposite to that occupied by the surgeon), about three inches above the patella; it is carried down across the ligament of the patella and up to a corresponding point on the opposite side of the thigh. This incision goes down to the bone; the flap is turned up and the joint exposed; the knee-joint is strongly flexed, and the synovial membrane and diseased ligaments are dissected away with scissors and forceps, great care being taken that the posterior ligaments (which, fortunately, are rarely implicated early

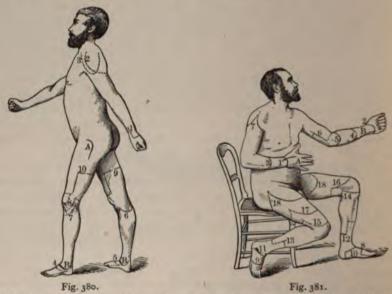


Fig. 380.—1-10, AMPUTATIONS (Joseph Bell): 1, of lower third of forearm (Teale's); 2, at shoulderjoint by large postero-external flap (second method); 3, at shoulder-joint by triangular flap from deltoid (third method); 4, 5, through tarsus (Chopart's); 6, 7, at knee-joint; 8, by single flap (Carden's); 9, 10, of thigh (Teale's). A, excision of hip; 8, of ankle-joint (Hancock's incision).

Fig. 381.—1-18, AMPUTATIONS (Joseph Bell): 1, amputation at wrist-joint (dorsal incision); 2, at wrist-joint (palmar incision); 3, at forearm (dorsal incision); 4, at forearm (palmar incision); 5, at elbow-joint (anterior flap); 6, at arm (Teale's); 7, at shoulder-joint (first method); 8, 9, of metatarsua (Hey's); 10, 11, at ankle (Syme's); 12, 13, of leg, posterior flap (Lee's); 14, at knee-joint (Carden's); 15, of thigh (B. Bell's); 16, of thigh (Spence's); 17, of thigh in middle third; 18, at hip-joint. A, excision of wrist (radial incision); 10, of wrist (ulnar incision).

in the case) are not divided and that the contents of the popliteal space remain intact. After removing the diseased ligaments and synovial membrane the cartilage is examined and any diseased portion is removed. The bone is then examined and any tuberculous foci are gouged away. Any exposed vessels are ligated. The wound is irrigated with salt solution, the extremity is straightened, and the ends of the ligamentum patellæ are sutured, a drainage-tube is inserted at each angle of the wound, the skin is sutured, and antiseptic or sterile dressings are applied. The limb is placed upon a posterior splint for a few days, then the drainage-tubes are removed, the dressings are changed, and a plaster-of-Paris cast is applied, trap-doors being cut on

each side, and the joint is kept immobile for two or three weeks. This operation is only suited to early cases in which the lesion involves chiefly or purely the synovial membrane and ligaments, and in these cases it frequently gives a good result, some capacity for motion being not unusually preserved.

Excision of the Shoulder-joint.—In the shoulder-joint partial excision is often performed, the head of the humerus being removed and the glenoid oring undisturbed; but some patients require complete excision, the entire glenoid depression, as well as the head of the humerus, being removed by the surgeon. Excision of the shoulder-joint is made, if possible, an intra-

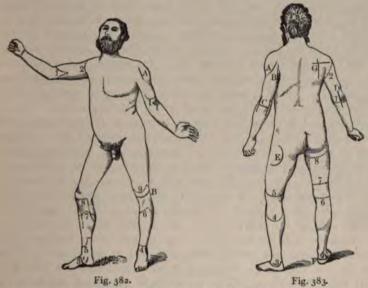


Fig. 382—1-9, AMPUTATIONS (Joseph Bell): 1, of arm by double flaps; 2, at shoulder-joint; 3, at ankle-joint by internal flap (Mackenzie's); 4, 5, of leg just above the ankle-joint (Syme's); 6, 7, below the knee (modified circular); 8, through condyles of femur (Syme's); 9, at lower third of thigh (Syme's). A, excision of head of humerus; B, of knee-joint (semilunar incision).

Fig. 383.—1-8, AMPUTATIONS (Joseph Bell): 1, at elbow-joint (posterior flap); 2, at shoulder-joint, posterior incision (first method); 3, at ankle-joint (Mackenzie's); 4, through condyles of femur (Syme's); 5, at lower third of thigh (Syme's); 6, at knee (posterior incision); 7, of thigh (Spence's); 8, at hip-joint. A-C, Excisions: A, excision of shoulder-joint (deltoid flap); 11, of shoulder-joint (posterior incision); C, of elbow-joint (H-shaped incision); D, of elbow-joint (linear incision); E, of hip-joint (Gross's); F, of os calcis; G, of scapula.

capsular operation, the capsule being opened, but the capsular attachment to the anatomical neck of the humerus not being interfered with. In advanced cases, however, the capsular attachment must be destroyed. Excision of the shoulder-joint is seldom performed in civil, but is a common operation in military practice; it is performed for gunshot-wounds, compound dislocations, tuberculous disease, and tumors of the head and upper portion of the humerus. The instruments required are a scalpel, an Adams saw and a metacarpal saw, an osteotome or chisel, a mallet, an Allis dissector, a periosteum-elevator, hemostatic forceps, dissecting forceps, toothed forceps, lion-jawed forceps, sequestrum forceps, metal retractors, curets, and cutting bone forceps.

Operation by Anterior Incision.—The patient lies supine; a pillow is placed beneath the shoulders, and a sand pillow is put beneath the shoulder to be operated upon. The arm is held to the side with the outer condyle forward and the bicipital groove inward (Barker's directions). The surgeon stands by the affected side. An incision three or four inches in length is made from just external to the coracoid process of the scapula, running straight down the humerus (Fig. 382, A). This incision divides the border of the deltoid muscle and brings into sight the long head of the biceps. The tendon of the biceps is retracted inward, unless it is diseased, in which case it is resected. The knife is carried up the groove and opens the capsule of the joint. The periosteum is lifted from the neck of the bone while an assistant rotates the elbow to make the muscles tense. In some places, if the periosteum tears, muscular insertions must be cut with a knife. The head of the bone is sawn off while the bone is in place, or the elbow is strongly pulled back, and the head of the bone is forced out of the wound, and is then sawn off at the point required. In ordinary cases only the articular head is removed; in other cases the section is made just above the surgical neck; in vet others a portion of the shaft must also be cut away. If the glenoid cavity is found slightly diseased, the dead bone must be removed by the chisel and mallet or by the cutting forceps. If the cavity is seriously diseased, the entire glenoid should be removed. Scrape away all damaged tissue; ligate bleeding points; irrigate the wound with corrosive sublimate solution; swab it out with a solution of chlorid of zinc (gr. xx to 3j); dust with iodoform; close the upper portion of the wound and insert a drainage-tube in the lower angle; dress the wound antiseptically; place a small pad in the axilla; apply the second roller of Desault; and put the patient in bed with a pillow under the affected shoulder. In seven days the hand-sling is substituted for the bandage, and with the elbow hanging free the patient is permitted to get up and is advised to move his arm frequently. Drainage is maintained until the wound is well healed from the bottom. Great limitation of movement inevitably follows a shoulder-joint resection.

Excision by the deltoid flap is performed when the head of the bone is much enlarged (as by a tumor) or when the tissues are thick and indurated. The deltoid flap is in the shape of a U or is semilunar (Fig. 383, A). Raising this flap exposes the head of the bone most satisfactorily. Bell states that when the glenoid cavity is chiefly involved the incision should be posterior

(Fig. 383, B).

Senn's Method.—Senn has recently described \* an incision which does not damage any important vessels, muscles, tendons, or nerves, and which is followed by good functional results. A semilunar skin-flap is formed, the incision running from the coracoid process to the posterior border of the axillary space. The flap is turned up, exposing the upper half of the deltoid muscle. The acromion is sawn off and turned down with the attached deltoid. The capsule is now freely exposed; it is opened, and either arthrectomy or excision is performed, according to conditions. In closing the wound it is not necessary to bore the acromion and pass silver wires to join the fragments; it is enough to suture the periosteum with catgut.

Excision of the Elbow-joint.—This operation is performed for wounds,

\* Phila. Med. Jour., Jan. 1, 1898.

faulty ankylosis, and chronic articular disease. Excision must be complete. Endeavor to make a subperiosteal resection; this maintains the shape of the articulation and gives the best chance for a movable joint. The instruments used are the same as those for the shoulder, plus a Butcher saw.

Operation.—The patient is "supine, but inclining to the sound side, the affected arm being held almost vertical, with the forearm flexed and nearly horizontal" (Barker). The incision is made on the posterior surface of the joint. A single posterior incision is usually employed (Fig. 383, D). An incision is made a little internal to the long axis of the olecranon, beginning two inches above and terminating two inches below the tip of the olecranon. This incision goes down to the bone, and throughout the entire operation the surgeon must guard and shield the ulnar nerve. The periosteum and soft parts are well separated; the olecranon is sawn off; forced flexion exposes the jointcavity freely, and enables the surgeon to lift the periosteum and soft parts from the humerus; the humerus is sawn through at the beginning of its condyloid processes; the radius and ulna are cleared and are sawn at a level below that of the base of the coronoid process of the ulna. Diseased tissues are cut and scraped away; the wound is irrigated, sutured, drained, and dressed. In some cases an H-shaped incision is employed (Fig. 383, c), but the cicatrix of a transverse cut will limit flexion of the limb.

After excision of the elbow the patient is put to bed and the arm is laid upon a pillow, the elbow being placed midway between a right angle and complete extension, the forearm being placed midway between pronation and supination. No splint is used, as a rule. Esmarch used the splint shown in Fig. 384. The aim in treatment is to obtain a freely movable

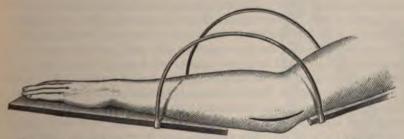


Fig. 384.-Esmarch's splint for the treatment of a limb after excision of the elbow-joint.

joint. Passive motion is begun in one week, at which time the patient gets up. The hand is carried in a sling for a time after healing of the wound is complete.

Excision of the Wrist-joint.—Bell states that, whatever method of excision is chosen, three cardinal rules must be borne in mind: (1) remove all the diseased bone, including the portions of the radius, ulna, carpus, and metacarpus which are covered with cartilage; (2) interfere with the tendons to the least possible degree; and (3) begin passive motion of the fingers very early. Many surgeons prefer the simple gouging away of diseased foci and the scraping of sinuses instead of a formal resection of the wrist, amputation being employed in severe cases or when scraping fails

after several trials. Formal excision is not frequently performed, and the results cannot be regarded as very favorable.

Lister's Open Method of Excision.—The instruments required in this operation are the same as those used for any resection. Break up adhesions as completely as possible by forcible movements. Apply a tourniquet or an Esmarch apparatus. The patient lies upon his back, the arm and the forearm being brought, from stage to stage, into the most desirable positions. Begin an incision over the middle of the dorsum of the radius, on a level with the styloid process; carry it downward in the direction of the inner edge of the articulation of the thumb with its metacarpal bone, and when the knife reaches the radial side of the second metacarpal bone alter the direction of the incision and carry it downward in the long axis of the metacarpal bone to about its middle (Fig. 381, A). This is known as the radial incision, and the only tendon divided is that of the extensor carpi radialis brevior muscle. The tissues upon the radial aspect of the incision are dissected up, the tendon of the extensor carpi radialis longior muscle is divided at its point of insertion (Bell), and all the soft structures are retracted outward, exposing the trapezium, which is cut off from the rest of the carpus, but which is left in place, as its removal at this stage endangers the radia artery (Barker). By extending the hand the tendons are loosened and the carpus is cleared in the direction of the ulnar border of the hand.

Another incision is made, starting upon the inner surface of the wrist, two inches above the articular surface of the ulna, and midway between the ulna and the flexor carpi ulnaris tendon. This incision, which is known as the ulnar incision, is carried down until it is opposite the middle of the fifth metacarpal bone in the palm (Fig. 381, B). "The dorsal lip of this incision is raised" (Bell), and the extensor carpi ulnaris tendon is divided and dissected from its depression, but is not separated from the integument. The extensor tendons are lifted; the ligaments upon the dorsum and sides of the wrist-joint are cut; the flexor tendons are raised from the carpal bones; the pisiform bone is cut from the carpus, but is not yet removed; and the unciform process of the unciform bone is cut with forceps. The anterior radiocarpal ligament is divided, the carpometacarpal articulations are cut through, and the carpus is pulled out with bone-forceps. The ends of the radius and ulna are forced out of the ulnar incision. All that portion of the ulna which is crusted with cartilage is to be removed, the saw-cut is to be oblique, and the base of the styloid process is to be left behind. A thin section is to be sawn from the radius, and the tendon-grooves are not to be impinged upon. The articular surface of the ulna is cut away with pliers (Bell). If foci of disease are discovered beyond these points, they are to be gouged out. The ends of the metacarpal bones are sawn off, and their articular facets are cut away by means of pliers. The trapezium is dissected out, the end of the first metacarpal bone is sawn off and its facet is cut away with pliers, and a portion of the pisiform bone is removed (the entire bone being removed if it be diseased). The wound is irrigated, vessels are tied, the radial incision is closed, the ulnar incision is partly closed, a drainagetube is inserted by way of the ulnar incision, the wounds are dressed antiseptically, and the Esmarch apparatus is taken off. The forearm and hand are placed upon a splint which immobilizes the wrist and leaves the fingers semiflexed. Passive motion of the fingers is begun after thirty-six hours. The splint is worn for many months, until the wrist-joint is immobile and solid. Esmarch uses the splint shown in Fig. 385.

Excision of Metacarpal Bones and of Phalanges.—Excision of a metacarpal bone, except in cases of necrosis with the formation of large

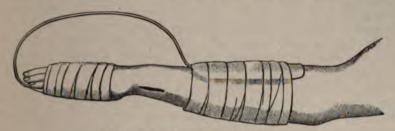


Fig. 385.-Esmarch's interrupted splint applied.

quantities of new bone, usually leaves a useless finger; hence amputation is preferred usually to excision. This rule does not apply to the metacarpal bone of the thumb, which is occasionally resected. The incision for this operation is made upon the dorsum, and is straight. Excision of the proximal phalanx of the thumb is sometimes performed. Excision for disease is rarely

performed upon the finger-joints, amputation being preferred, though the operation is sometimes undertaken for compound dislocation. In the metacarpophalangeal joint of the thumb excision, if it can be performed, is preferred to amputation. The incision for resection of this joint is placed upon the radial aspect.

Excision of the Hip-joint.—Some surgeons advocate this operation; others, notably Marsh, are emphatically opposed to it. Excision should be performed in the early stage of tuberculous disease if less radical treatment has failed. In this stage the usual position of the limb is one of flexion, abduction, and eversion. In cases of long duration, especially where dislocation exists, excision is an easy and a comparatively safe operation; in recent cases it is difficult and carries with it decided dangers, but the peril of delay may be greater than the peril of an early resection. In cases of hip disease with involvement of the acetabulum the mortality is 50 per cent., whether operation is or is not at-

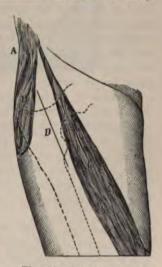


Fig. 386.—Excision of the hipjoint: A, Gluteus muscle; B, tensor vaginæ femoris muscle; c, sartorius muscle; D, anterior incision.

tempted. Excision is performed especially for tuberculous disease and for gunshot-injuries. The instruments required are those used for other excisions.

Operation by Anterior Incision (Fig. 386) (Barker's Operation).—In this operation the patient is supine, with the thighs extended as thoroughly as circumstances permit. The surgeon stands to the right of the patient. An

incision is begun half an inch below and half an inch external to the anterior superior iliac spine, and it is carried downward and a little inward for about three inches (Fig. 386, D). If dislocation exists, the incision must not be so long. This incision is carried at once deeply between the muscles, and the capsule of the joint is opened. The neck of the bone is divided from its upper surface downward with a saw or an osteotome, and without dislocating the bone through the wound by forcible extension and eversion. The head of the bone is removed. All tuberculous foci must be scraped away, and the flushing gouge is used upon tuberculous areas of the acetabulum. All sinuses should be thoroughly scraped. Bleeding is arrested, the wound is irrigated with normal salt solution, mopped out with chlorid of zinc solution, and dusted with iodoform. A drainage-tube is inserted at the lower angle of the incision, and the upper portion of the cut is closed. The wound is dressed antiseptically. Extension is made with the extension apparatus until healing has obtained good headway, when a double Thomas's splint is applied, so that the patient can be taken out daily in the air and sunlight. As a rule, rigid ankylosis results from resection of the hip, but occasionally a joint results with a small range of movement.

Operation by Lateral Incision (Langenbeck's Operation).—In this operation a straight incision two inches long is made in the direction of the axis of the femur, and passing downward from the apex of the great trochanter. From the beginning of this incision a curved incision is carried toward the head of the bone, the convexity of the curve being backward (Fig. 380, A). Bell advises the use of the saw after bringing the head of the bone into the wound by abduction and eversion of the thigh. Barker applies the saw with the bone in situ, and strongly opposes wrenching the bone out of the incision, because of the danger of peeling off the periosteum, which peeling, if it takes

place, favors necrosis.

Incision of Gross.-In Gross's operation a semilunar flap is made with

the convexity backward (Fig. 383, E).

Excision of the Knee-joint.—In this operation a complete excision should be performed, and the patella ought to be removed. This operation is performed for tuberculous disease, some compound fractures and compound dislocations, and some cases of angular ankylosis, but it is rarely employed for gunshot-injuries, amputation being usually preferable. The instruments required are the same as those for the shoulder, plus Butcher's saw.

Operation by Anterior Semilunar Flap.—The patient lies upon his back, and the joint, if not ankylosed in extension, should be semiflexed. The surgeon stands to the right side. An incision is made which at once opens the joint. The incision begins at one condyle and reaches the other condyle by a curve which passes through the ligamentum patellæ midway between the tuberosity of the tibia and the inferior margin of the patella (Fig. 382, B). The flap is dissected up, the knee is thrown into forced flexion, the lateral ligaments and crucial ligaments are cut, and the end of the femur is well cleared. The blade of Butcher's saw is passed beneath the bone, which is sawn from below upward (Ashhurst). The end of the tibia is cleared and a portion is sawn off. If, after sawing, diseased foci are discovered, another section can be sawn off or

the foci can be gouged away. Ashhurst, who has had a vast experience with this operation, insists that in sawing through the femur the natural obliquity of the bone must be borne in mind and the section must be made in "a line parallel to that of the free surface of the condyles." If the section is made transverse to the axis of the femur, "the limb, after adjustment, will be found to be markedly bowed outward." The same surgeon says that the epiphyseal line is somewhat higher on the front than it is on the back of the femur, and in consequence the following rule is formulated for section of the condyles: the section of the condyles should be "in a plane which, as regards the axis of the femur, is oblique from behind forward, from below upward, and from within outward." Ashhurst advocates section of the tibia "in a plane transverse to the long axis of the bone, with a slight anteroposterior obliquity, so as to correspond with that of the section of the condyles," and he further says that the patella must be removed, whether it is diseased or not, and quotes Péniére's observations to the effect that excision of the patella diminishes the risk of death one-third, and its retention doubles the probability of an amputation becoming necessary in the future.

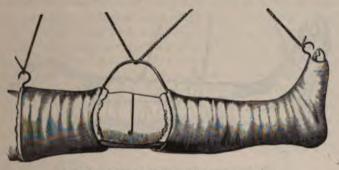


Fig. 387.-Watson's plaster-of-Paris swing-splint.

After removing the patella the diseased synovial membrane is clipped away with scissors and all sinuses and diseased territories are well curetted. The posterior ligament of the joint is not removed unless it is diseased; its retention prevents displacement and guards the popliteal space. In children the fragments should be wired together; in adults this need not be done. After hemostasis, irrigate, dust with iodoform, insert a drainage-tube, suture, dress antiseptically, and adjust the limb upon Price's splint or Ashhurst's bracketed wire splint. In some cases tenotomy is required to permit extension. Instead of the bracketed splint, a long fracture-box may be used. If the femur tends to project anteriory, use an anterior splint. If there be a tendency to outward bowing, adopt Ashhurst's expedient of carrying a strip of adhesive plaster around the outside of the limb and fastening it to the inner side of the splint. The splint is kept on until bony union is complete, as in this operation a movable joint is never sought. Many surgeons use a plaster-of-Paris splint, which is employed until the parts have become firm and solid (Fig. 387).

Excision of the Ankle-joint.—This operation is performed chiefly for gunshot-wounds, compound dislocations, and in some cases of tuberculous

joint-disease. Excision of the ankle is an operation which is seldom performed. The instruments used are the same as those employed for any resection.

Operation (Hancock's Method).—In this operation the patient lies upon his back, the foot rests upon its inner side, and the surgeon stands to the outer side of the damaged limb. Begin an incision just behind and two inches above the external malleolus, and carry it across the front of the joint to a corresponding point above and behind the internal malleolus (Fig. 380, B); this incision goes only through the skin, and the flap thus marked out is reflected. "Cut down upon the external malleolus, carrying the knife close to the edge of the bone both behind and below the process, dislodge the peronei tendons, and divide the external lateral ligaments" (Joseph Bell). Cut the fibula one inch above the malleolus by means of pliers; divide the tibiofibular ligament; turn the foot upon its outer side; dissect from their habitat back of the inner malleolus the tendons of the posterior tibial and the common flexor of the toes; carry the knife around the inner malleolus, close to the bony edge; separate the internal lateral ligament, and dislocate

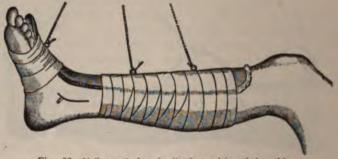


Fig. 388.-Volkmanu's dorsal splint for excision of the ankle.

the lower end of the tibia through the wound by turning the sole of the foot downward; saw off the lower end of the tibia and the articular process of the astragalus, sawing away from the tendo Achillis, and remove the fragments with bone forceps. Cut away diseased synovial membrane, and curet all sinuses and tuberculous areas. Arrest bleeding, irrigate, and drain. Sew up the wound, insert a tube at the outer angle, and cause it to emerge at the inner angle. Apply antiseptic dressings, and put up the foot in fixed dressing or in splints at a right angle to the leg (Fig. 388). In Langenbeck's operation the excision is subperiosteal. If, in an excision of the ankle-joint, the astragalus is found extensively diseased, remove the entire bone.

Excision of the Os Calcis.—In caries limited to the os calcis most surgeons prefer to gouge away the dead bone, leaving the periosteum and, if possible, a shell of healthy bone, and draining thoroughly. Others advocate excision in some cases. Extensive disease limited purely to the os calcis is rare, and most surgeons advise gouging for limited caries, and Syme's amputation in the event of the disease extending beyond the periosteum or reaching adjacent bones.

Operation by Subperiosteal Method.—In this operation the position as-

sumed by the patient is supine with the leg extended and the foot resting on its inner side. The incision, which cuts the tendo Achillis and reaches the bone at once, is begun at the upper border of the os calcis and the inner margin of the tendo Achillis, and is taken outward and horizontally forward to a point in front of the calcaneocuboid articulation (Fig. 383, F). A vertical incision is begun near the forward termination of the initial incision, is carried across the outer edge and plantar surface of the foot, and terminates at the external margin of the inner surface of the os calcis. Some surgeons carry the vertical incision a little upward, toward the dorsum. The periosteum is entirely stripped with an elevator, the os calcis is removed, the cavity is packed with iodoform gauze, the wound is stitched, a drain is inserted posteriorly, and the foot is dressed antiseptically, is placed at a right angle to the leg, and plaster-of-Paris is applied, trap-doors being cut for drainage.

Astragalectomy, or excision of the astragalus, is seldom performed. Astragalectomy is employed occasionally for relapsed and inveterate cases of dub-foot. The indications are pointed out by Willard ("International Clinics," vol. iii, 12th series): "(1) Adults with great bony deformity; (2) neglected children of five to fifteen years, who have markedly distorted their tarsi by locomotion; (3) relapsed cases which have resisted the milder forms of operation, or which have been neglected by parents after previous operation; (4) only occasionally, young children in whom from infancy the bones of the foot have been exceedingly rigid and unyielding, and where there is practically but little motion either at the ankle-joint or in the tarsus."

Operation by the Subperiosteal Plan.—Barker advises an incision going at once to the bone, from the "tip of the external malleolus forward and a little inward, curving toward the dorsum of the foot." The foot is extended and turned inward, the periosteum is lifted, the astragalus is removed, and the wound is treated and the foot is dressed as is done in excision of the os calcis.

Excision of the Metatarsophalangeal Articulation of the Great Toe.—In this operation make a lateral incision and cut off or saw off the proximal end of the first phalanx and the distal third of the first metatarsal bone.

Excision of the Metatarsal Bone of the Great Toe (Butcher's Method).

—In this operation a lateral straight incision is made, the periosteum is elevated, and the shaft is sawn from each extremity and removed.

Excision of the clavicle may be required for dislocation, caries, necrosis, gunshot-wound, tumor of this bone, as a preliminary to ligation of the artery and vein in certain cases of amputation at the shoulder-joint, or in cases of removal of the entire upper extremity. In excision of the clavicle the position of the patient is the same as that for ligation of the third part of the subclavian artery (page 479). An incision is made down to the bone, from the sternoclavicular joint to the acromioclavicular articulation. If the case is suitable, the periosteum is stripped and the bone is sawn and removed; if not, the bone is sawn and each half is separately disarticulated. The wound is sutured and dressed, and the limb is put up in a Velpeau bandage.

Excision of the Scapula.—Complete excision of the scapula is usually performed for tumors. Partial excision requires no detailed description.

In excision of the scapula the patient lies upon his sound side. Treves suggests the following incisions: one outside the vertebral border of the scapula, from its superior to its inferior angle; another from over the acromioclavicular joint, along the acromion process and spine of the scapula, to meet the first incision. Syme used an incision carried transversely inward from the acromion process to the vertebral border of the scapula, and another cut directly downward from the center of the first incision (Fig. 383, G). In the method of Treves\* the upper flap is reflected and the trapezius muscle is divided; the lower flap is reflected and the deltoid muscle is divided. The patient's hand is placed on the sound shoulder; the muscles of the vertebral border are divided, the posterior scapular artery is tied, and while the vertebral border of the scapula is pulled toward the surgeon, the serratus magnus muscle is cut, the upper border of the shoulder-blade is cleared, and the suprascapular artery is tied. The hand is now brought down to the side; the acromioclavicular joint is disarticulated; the conoid and trapezoid ligaments are divided; the muscles of the coracoid process are cut; the capsule is incised, with the supraspinatus and infraspinatus, the subscapularis, and the scapular origins of the biceps and triceps muscles; and finally the teres major and minor muscles are divided, the subscapular artery is tied, and the bone is removed. The wound is stitched, a drain is introduced, and antiseptic dressings are applied. The patient lies upon his back until healing is well under way, when the arm is placed in a sling. The drainage-tube may be removed in twenty-four hours.

Excision or Resection of a Rib (Fig. 494).—In caries the gouge and rongeur may remove the disease. In other cases excision is performed. In this operation the patient lies upon his sound side unless the operation is performed for empyema, in which case he lies on his back or only partly on the sound side. (See Empyema, Operation for.) The surgeon faces the patient. Make an incision down to the bone, in the long axis of the rib. The periosteum, if not diseased, is lifted from the bone, and the intercostal artery is lifted out of the way with the periosteum and is thus saved from being cut. After dividing the bone beyond the limits of disease, remove it. During the sawing a metal retractor is held beneath the rib, between the rib and the periosteum. It is better to saw it than cut it with ordinary biting forceps, because the latter splinter the bone. The author usually uses a forceps known as a costolome, which cuts the rib without splintering. If the periosteum is diseased, remove it after tying the intercostal artery. It should be removed in a case of empyema, otherwise boneformation may interfere with drainage. In empyema, after removing the periosteum, open into the pleural cavity, allow pus to flow out slowly, remove fibrinous masses, employ a finger to feel if there are adhesions and if the lung will probably expand, and insert a drainage-tube. In resection for rib disease curet sinuses and pack with iodoform gauze for some days. Sew up the wound except at one end. Dress antiseptically and apply a binder. (See Operations upon the Chest and Estlander's Operation.)

In removing a cervical rib make an incision along the posterior edge of the sternocleidomastoid, avoid the pleura, subclavian vessels, and brachial plexus, and remove the periosteum with the rib in order that the bone will not be reproduced.

Complete Excision of One-half of the Upper Jaw.—The whole upper \*Treves's "Manual of Operative Surgery."

jaw has been removed, but in what follows only resection of one-half the jaw will be described. This operation is performed for malignant tumors of the superior maxillary bone or its antrum. Up to 1826, at which time Lizars, of Edinburgh, suggested the operation, tumors of the antrum were treated by scraping them away with a sharp spoon. Gensoul, of Lyons, in 1827 performed the first operation for resection of the upper jaw. This operation is not justifiable, except as a palliative measure, if the orbit is invaded,

if the skin and subcutaneous tissues are infiltrated, or if the disease extends widely beyond the superior maxillary and palate bones. The instruments required are: a mouth-gag; scalpels; strong scissors; tracheotomy tubes; dissecting, toothed, and hemostatic forceps; bone-cutting, lion-jaw, sequestrum, and toothextracting forceps; a volsella; a narrowbladed saw; a chisel and mallet; a periosteum-elevator; a spatula or metal retractor; Paquelin's cautery; sponges which are tied to sticks; needles, curved and straight, large and small; silk and catgut ligatures; silk wormgutsutures; and Horsley's antiseptic bone-wax.

Preliminary Closure of the External Carotid Artery.—Some surgeons ligate the external carotid artery or compress it temporarily. In a number of excisions of the



Fig. 389.—A B, Incision of the soft parts preliminary to excision of the upper jaw; CDE, incision of soft parts preliminary to excision of the lower jaw.

upper jaw I have always found the hemorrhage readily controllable as soon as the bone is removed, and have never felt it necessary to resort to prelimi-

nary ligation or compression.



Fig. 190.—1, Excision of the upper paw: A B, Section of the anal process; B C, section of the orbital plate; D, section of the malar bone and orbital plate; R, section of the alveolem and bard palate. 2, Excision of the lower jaw: G, Section of the inferior maxillary; 84, section of the ramus in partial resection.

Operation by Median Incision.-The patient, whose face has been shaved, is placed in the Trendelenburg position, thus avoiding the possible need of instant tracheotomy. The surgeon stands to the right side of, and faces, the patient. The incisor tooth on the diseased side is pulled out. The incision, which is known as Weber's incision (Fig. 389, line A B), is begun half an inch below the inner canthus of the eye, and is carried along the side of the nose, around the ala of the nose, by the margin of the nostril, and through the middle of the lip. While the lip is being incised the assistant arrests hemorrhage by grasping the corners of the mouth, and after the lip is divided, the coronary arteries are at once ligated. Some operators approach the mucous membrane cautiously and ligate the vessels before opening the cavity of the mouth. The upper portion of the wound having been compressed by another assistant during these manipulations, pressure is now removed and bleeding points are ligated. Another

ncision is now carried outward from the beginning of the first incision, along

the orbital margin to well over the malar bone. The flap is lifted from the periosteum, and the bleeding from the infraorbital artery and the small vessels is restrained by pressure. The nasal cartilage is separated from the bone, and the nasal process of the superior maxillary is sawn (line A B, Fig. 300). The orbital periosteum is lifted up, and the orbital plate is cut with forceps from the saw-cut in the superior maxillary bone to the sphenomaxillary fissure (line BC, Fig. 390). The malar bone is sawn or is bitten through about its center, the cut running into the sphenomaxillary fissure and taking a downward and outward direction (line c D, Fig. 390). The soft parts covering the hard palate are incised in the median line, a corresponding incision is made along the floor of the nose near the septum, and the soft palate is separated from the hard palate by a transverse cut. The saw is introduced through the nose, and the palate is sawn (line E, Fig. 300). The upper jaw-bone is grasped with Fergusson's lion-jaw forceps and removed. the removal being aided by the use of the scissors and bone-cutters; the latter are used to separate the upper jaw from the pterygoid process (Treves). Every vessel that can be seen is tied, and severe bleeding from bone is arrested by antiseptic wax. Oozing is controlled by hot water and pressure or by Paquelin's cautery. Examine carefully to see if all the diseased area is removed; if it is not, use the gouge, scissors, chisel, and saw until healthy tissue is reached. The wound is packed with iodoform gauze, and the end of the strip is so placed as to be accessible through the mouth. The wound is sutured (the mucous membrane of the lip must be stitched, as well as the skin) and is dressed antiseptically (the eye being protected by aseptic gauze), and a crossed bandage of the angle of the jaw is applied.

Excision of One-half of the Lower Jaw.—In some rare instances the entire inferior maxillary bone is removed. The lesions necessitating removal of the lower jaw are of the same nature as cause us to remove the upper jaw. The instruments required for removal of the lower jaw are those used for excision of the upper jaw, plus a metacarpal saw (having a

movable back).

In this operation the patient is placed in the same position as for excision of the upper jaw, the chin having been previously shaved. A vertical cut is made through the chin-tissue, starting below the margin of the lip and reaching to below the border of the jaw (c D, Fig. 389). From the point D an incision is carried outward below the border of the jaw and then back of the ramus, as shown in the line DE (Fig. 389). Treves's advice is to carry this incision down to the bone, except at the line of the facial artery, at which point it must go through the skin only. The facial artery is now to be sought for, tied in two places, and divided. The periosteum is lifted from the external surface of the bone, from the symphysis outward. Hemorrhage is arrested. The buccal mucous membrane is cut from the alveolus. A lateral incisor tooth is pulled, and the bone is sawn in the line G (Fig. 390). The bone is grasped in a lion-jaw forceps and is drawn outward. The mylohyoid insertion is cut; the internal pterygoid muscle is cut or the periosteum at this spot is lifted; the inferior dental artery is cut and tied; the jaw is pulled down; the insertion of the temporal muscle upon the coronoid process is cut away; and the external pterygoid muscle is divided. The capsule of the joint is opened, and the bone is separated from the ligaments which still hold it in place. Bleeding is arrested, the wound is sutured, a tube is introduced in the posterior portion of the wound and retained for twenty-four hours, and antiseptic dressings and a Gibson or a Barton bandage are applied. Partial excisions of the alveolus may be performed through the mouth by means of chisels and rongeur forceps, and Wyeth has thus removed half of the jaw; but if any considerable part of the body of the jaw is to be removed, it is usually best to make an incision below the inferior maxillary.

Barker's Operation for Dislocation of the Semilunar Cartilages of the Knee-joint.\*—Begin the incision over the ligament of the patella, half an inch above the articular surface of the tibia, and carry it in a curve downward and outward to the anterior edge of the internal lateral ligament. The periosteum should be divided by the cut. This incision forms a flap the lower edge of which is half an inch below the border of the articular surface of the tibia. The flap is lifted until the cartilage is seen "under the attachment of the meniscus, which if partially attached will rise with the flap until its under surface is seen." If partially torn anteriorly it is stitched to periosteum by a few silk sutures. The periosteum is then stitched in place, no drain is used, the joint is immobilized, and for one week ice is kept upon the part. If the meniscus is found completely separated and curled up, it may, if the injury was recent, be reduced. If the injury was old and if the cartilage is shrunken, it should be completely cut away (Barker).

Operation for Congenital Dislocation of Hip.-Lorenz's Bloodless Method of Reduction. - The method of reducing by manipulation a congenital dislocation of the hip was devised by Paci and modified and improved by Lorenz. It has long been known that reduction is easy at birth, because an acetabulum, though probably a shallow one, exists and the head of the bone is not firmly held in its new situation. In an older child the problem is far more difficult, because, even if reduction is effected, the acetabulum may be extremely shallow or absent, and redislocation may readily occur. Lorenz aims to effect thorough reduction and then fixes the limb in abduction for months, so that the acetabulum will deepen and the bone will become firm in its proper socket. This operation is rarely successful in children over six years of age. The child is anesthetized and an attempt is made to draw the femoral head on to a line with the acetabulum. If the child has never walked, this is readily accomplished. If it has walked, the procedure may be very difficult, and it may be necessary to make extension with a fillet fastened above the knee, and counter-extension with a screw and a perineal band. The drawing down of the head is made easier by stretching and massaging the adductor muscles. The next step is to strongly flex the thigh, rotate it a trifle internally, and then abduct it while flexion is maintained. This causes the head of the femur to pass around the posterior margin of the acetabulum and frequently produces reduction. "Full abduction being kept up, the thigh is rotated out, thus forcing the head of the femur more firmly into the socket" (see the description of the Lorenz method in J. Jackson Clarke's "Orthopædic Surgery"). The strongly abducted limb is put up in plaster-of-Paris. In about three months the plaster is removed, the abduction is diminished, the plaster is reapplied and is retained for another three months. During the continuance of immobilization of the hip, the child

<sup>\*&</sup>quot; Lancet," Jan. 4, 1902.

walks about, with the knees bent. When the plaster is finally removed, manipulation, massage, and exercise strengthen the muscles and give freedom to the joint. In a double dislocation one joint can be cured before the other is operated upon, or both may be operated upon at the same séance. In double dislocation plaster must be worn more than six months. The Lorenz operation is safe when applied to very young children, but has elements of danger which increase with the years of the subject. A patient may suffer grave lacerations of muscles and ligaments, and even vessels and nerves. Death may result from shock, and extensive deep-seated hemorrhage may occur. In fact, it is a mistake to call it a bloodless method. The blood flows, though we do not see it. An untrained man may do fearful mischief by this operation, and it should only be attempted by a very skilful manipulator and upon properly selected cases, when it is a very successful procedure. I am satisfied



Fig. 391.—Lorenz method Unilateral congenital dislocation of hip (reduced). Cast applied with leg in "frog position."

that, except in the case of a very young child, in whom reduction is easy, one who performs the Lorenz operation should be something more than skilful and experienced. He should be physically strong, so that traction and abduction will be powerful and steady. A weak man will jerk, will throw his weight upon the part, and will be apt to tear structures instead of stretching them. Sudden forcible movements are apt to break the bone.

Hoffa's Operation.—The instruments used are the same as for a resection. Make the external incision of Langenbeck to open the joint (page 716). The capsule is incised at its insertion into the neck, and the periosteum and muscles are lifted from the great trochanter. Hoffa claims that in children less than five years of age the head of the bone can be readily replaced into the acetabulum by flexing the thigh and making direct pressure upon the head of the bone. After replacing the femoral head it is held in place while an assistant extends the leg in order to stretch the muscles. In children over five years of age cut the muscles which spring from the ischial tuberosity and also the adductors with a tenotome; cut the fascia lata and muscles which arise from the anterior superior iliac spine by incision; open the joint and liberate

the head of the bone; remove the ligamentum teres; scrape out the acetabulum, removing "cartilage, fat, and considerable spongy tissue" (Tubby); and replace the head of the bone in the acetabulum. The limb is maintained in inversion, abduction, and extension for several weeks, when it is straightened. Massage and passive motion are begun in the fifth week. The patient now gets about, wearing an apparatus for many weeks. This apparatus permits the head of the bone to move in the socket, but prevents redislocation.

Lorenz's Operation.—This is a modification of Hoffa's. The muscles inserted into the greater and the lesser trochanter are not cut; the sartorius, the hamstrings, and the external portion of the fascia lata are cut (Tubby).

The incision of Lorenz is longitudinally from the anterior superior spine. Another incision is carried inward from this at the level of the lesser trochanter. The capsule is opened by a crucial cut; the acetabulum is enlarged; the head of the bone, if it remains, is inserted into the acetabulum; if there is no true head, a new one is formed and inserted into the cavity. The limb is immobilized in a position of moderate abduction. Massage and passive motion are begun in the fifth week, and are continued for months.\*

<sup>\*</sup>I have drawn upon the very lucid description of these operations in A. H. Tubby's treatise upon "Deformities."

## XX. DISEASES AND INJURIES OF MUSCLES, TENDONS, AND BURSÆ.

Myalgia, or muscular rheumatism, is a painful disorder of the voluntary muscles and of the fibrous and periosteal areas where they are attached. The term "muscular rheumatism" is not strictly correct. It is possible that in some cases the muscular structure is inflamed, but it is certain that in many cases the pain is distinctly neuralgic. Muscular rheumatism may be due to cold and wet, to over-exertion and strain, to acute infectious disorders, to syphilis, to chronic intoxications (lead, mercury, and alcohol), and to disturbances of the circulation. Gouty and rheumatic persons are especially predisposed, men being more liable to the disease than women. The disease is usually acute, but it may be chronic.

Symptoms.—Muscular rheumatism is apt to come on suddenly. The pain, which may be very acute and lancinating or may be dull and aching, is in some cases constantly present; in other cases it is awakened only by muscular contraction, and it is frequently relieved by pressure, though there is often some soreness. The skin above the muscle is sometimes tender to light pressure. The disease usually lasts for a few days, but it tends to

recur. There is little, if any, fever.

Lumbago is myalgia of the muscles of the loins. Rheumatic torticollis is myalgia of the muscles of the neck. Usually one side of the neck is attacked. The chin is turned from the affected side and the neck is stiff. Pleurodynia is myalgia of the intercostal muscles. The pain is very severe, is aggravated by deep respiration, by coughing, and by yawning, there may be tenderness, and the patient tries to limit chest-movement. In intercostal neuralgia the pain is limited, is not constant, but occurs in distinct paroxysms, and is linked with the presence of the tender spots of Valleix. Pleurodynia lacks the physical signs of pleurisy. Cephalodynia is myalgia of the muscles of the scalp. The muscles of the shoulder, upper dorsal region, abdomen, and extremities may also be attacked by myalgia. Myalgia must not be confused with the pains of locomotor ataxia.

Treatment.—Remove any obvious cause. Treat any existing diathesis, such as gout or rheumatism. Rest is of the first importance. For lumbago, put the person to bed. For pleurodynia, strap the side of the chest. A hypodermatic injection of morphin and atropin into the affected muscles at once allays the pain, and a deep injection of distilled water is sometimes curative. Relief may be afforded by painting the surface with 30 drops of a mixture of equal parts of guaiacol and glycerin and covering the painted area with cotton. The introduction of four or five aseptic needles into the muscles, and their retention for a few minutes, sometimes acts most favorably. Ironing the skin above the painful muscles with a very warm iron, a piece of flannel being interposed, is a useful domestic remedy. Vigorous rubbing of the area with a piece of ice allays the pain. Hot poultices do good. If the pain is widely diffused, alters its seat, or is very obstinate, order hot baths or Turkish baths and administer diuretics. In chronic cases employ blisters or counter-irritation by the cautery, give iodid of potassium and nux vomica, and have the patient take a Turkish bath every week. The constant electric current finds advocates. In an ordinary severe case order a hot bath, put the patient to bed with a hot-water bag over the part, and administer 10 grains of Dover's powder; the next morning order to be taken four times daily a capsule containing 5 grains of salol and 3 grains of phenacetin, until the pain disappears. Citrate of potassium, citrate of lithium, chlorid of ammonium, or the salicylate of colchicin may be ordered instead of salol and phenacetin.

Infective myositis is a wide-spread inflammation of the voluntary muscles, due to an unknown infective cause. It is a disorder accompanied by pain and stiffness, by cutaneous edema, and by various paresthesiae. Myositis resembles trichinosis, and is distinguished from it only by spearing out a bit of muscle and examining it microscopically. Occasionally diffuse

suppuration occurs.

Ordinary myositis arises from injuries, from syphilis, or from rheumatism, and it presents the usual inflammatory symptoms. Contraction and adhesions may follow. I operated upon a case of myositis of the rectus abdominis in a boy of eight. There was a large mass like a full bladder. There had not been an attack of typhoid and there was not hereditary syphilis. Caseation existed. The condition was possibly tuberculous, although no bacilli were found.

Treatment of Myositis.—Infective myositis is treated by anodynes, stimulants, nutritious food, hot applications, and rest. If pus forms, it should be evacuated. Rheumatic myositis calls for the administration of the salicylates, the alkalies, or salol. Syphilitic myositis is treated with mercury and iodid of potassium. The remedies employed for myalgia are used in traumatic myositis.

Hypertrophy of the muscles may arise from their increased use. In pseudohypertrophic paralysis the bulk of the muscle is greatly augmented, but it contains less muscle-structure and more fat or connective tissue.

Atrophy of the muscles arises from want of use, from injury, from continuous pressure, from interference with the blood-supply, from disease of the nerves or their centers, or from lead-poisoning.

Degeneration of Muscles.—The muscles may undergo granular degeneration, waxy degeneration, fatty degeneration, and calcareous degen-

eration, and may become pigmented.

Local Ossification and Myositis Ossificans.—It is not unusual for a small portion of bone to form in the periosteal insertion of a muscle which is subjected to frequent strain. In persons who ride many hours a day there not infrequently develops the "rider's bone," which is an area of ossification in the adductor muscles of the thigh. Myositis ossificans, a wide-spread ossification of the muscles, is a rare disorder the cause of which is unknown, and which, if not congenital, at least begins in early life. In some cases a traumatic origin seems probable. It is seen more often among males than females. Columns of inflammatory swelling and induration slowly develop, each column running in the direction of the muscular fibers, and ossification of the indurated columns takes place. It is stated that the thumbs and great toes shorten (J. Jackson Clarke's "Orthopædic Surgery").

Tumors of the Muscles.—Primary tumors of the muscles are rare.

Among those which may occur are sarcoma, fibroma, lipoma, osteoma,

angioma, myxoma, and enchondroma. Most cases of supposed primary sarcoma of muscle are in reality cases of syphiloma (Esmarch).

Syphilis may cause inflammation. Gummata may form, or gumma-

tous infiltration may take place.

Trichinosis or trichiniasis is a disease due to the embryos of the trichina spiralis. The disease originates from eating meat which contains the trichinæ and has been insufficiently cooked. These nematodes are carried into the intestine, there to develop and multiply. In from seven to nine days a horde of embryos develop in the bowel, and leave the alimentary canal by passing through the peritoneum or by means of the blood, and finally reach the connective tissue of the muscles. From the connective tissue the embryos migrate into the primitive muscle-fibers, where they dwell and enlarge. Myositis develops, and in the course of five or six weeks the parasites become encapsuled and develop no further. The cyst-walls may calcify and the worms may become calcified, or may live for years. The eating of infected meat is not inevitably followed by the disease, and a few embryos

lodged in muscle may cause no symptoms.

Symptoms.—The symptoms of trichinosis often appear in a day or two after eating infected meat. The symptoms of acute gastro-intestinal catarrh or of cholera morbus are common, but in some cases no gastro-intestinal manifestations usher in the disease. In from seven to fourteen days after the infected meat is eaten the migration of the parasites develops obvious symptoms. A chill may be noted; there is usually fever; muscular pain, tenderness, swelling, and stiffness are complained of. This condition may be wide-spread. Involvement of the muscles of mastication interferes with chewing; of the larynx, with talking and respiration; of the intercostals and diaphragm, with respiration. Skin-edema and itching are marked. In some cases delirium exists. The writer saw in the Philadelphia Hospital one fatal case which was mistaken for erysipelas because of the high fever, the delirium, and the edematous redness of the face and neck. Dyspnea is frequent. Mild cases get well in a week or two; severe cases may last many weeks. The mortality varies in different epidemics from 1 to 30 per cent. (Osler). The diagnosis is made by spearing out a piece of muscle, which is then examined for trichinæ under a microscope; or the worms may perhaps be detected in the feces by means of a pocket-lens. In a case under the care of the author, in St. Joseph's Hospital, there was no record of any attack of gastro-intestinal disturbance and the first manifestation was enlargement of the calf of the left leg. In most cases of trichinosis there is eosinophilia, but in the author's case, previously referred to, cosinophilia was not present.

Treatment.—To treat trichinosis employ purgatives (senna and calomel) early in the case, and give glycerin, and also santonin or filix mas. When muscular invasion has taken place, sedatives, hypnotics, nourishing diet, and stimulants are indicated.

Ischemic Myositis, or Volkmann's Contracture (Volkmann's paralysis; Ischemic paralysis; Ischemic muscular alrophy with contractures and paralysis, Fergusson calls it) .- It is occasionally noticed, particularly in children, after prolonged fixation of the forearm, especially after prolonged fixation of the elbow-joint by some appliance that impedes the freedom of circulation in the part. Contracture of the fingers occurs and per-

haps rigidity and flexion of the wrist. In 1875 Volkmann described severe contractures of the hand observed in some cases as a result of the use of tight bandages to hold splints in place in treating fractures of the arm. He believed that the condition was due to deprivation of arterial blood, that the muscles perished for want of oxygen, and that rigor mortis occurred. He pointed out that paralysis and contracture occur simultaneously, whereas, in primary nerve lesion paralysis precedes contracture. The condition may come on after the application of an Esmarch band, after a severe injury in the neighborhood of the elbow-joint, may follow ligation of the main artery of a limb, venous embolism, venous thrombosis from injury or infectious disease, Raynaud's disease, or exposure to cold. One of Jones' cases followed a rapidly developing traumatic myositis ossificans; two followed crushes; in one an elastic tourniquet had been kept on a child's arm to prevent bleeding after an operation for webbed fingers; in one pad pressure had been maintained for twenty-four hours to check bleeding ("Am. Jour. Orthop. Surg.," April, 1908). There are two forms, one due to almost complete arterial ischemia, lasting for several hours at least; another due to interference with venous return. Volkmann's contracture is due to a muscular degeneration, infiltration, induration, and contraction, the result of marked and prolonged arterial ischemia or interrupted venous return, and it is frequently spoken of as ischemic myositis (Dudgeon, "Lancet," Jan. 11, 1902). In some cases distinct neuritis with paralysis also exists. One characteristic of ischemic contracture is the rapidity with which it comes on. Dudgeon points out that in half a day, or even in less time in some cases, the symptoms appear, these symptoms being paralysis of the part with contracture. Pain is unusual, unless the nerves are seriously involved. In some cases the fingers and hand swell and become discolored. The absence of pain frequently prevents the recognition of the condition; therefore, the causative splint or bandage pressure may be maintained for days after the trouble has become serious. When the splints and bandages are removed and the forearm is examined, there is almost always tenderness over the muscles and the nerve-trunks; and in the majority of cases in which a splint was the cause, a portion of the skin will have sloughed. Dudgeon points out the characteristic position of the deformity, as follows: When the wrist is extended, the metacarpophalangeal joints are also extended; but the interphalangeal joints of the fingers and the terminal joint of the thumb are so strongly bent that the tips of the fingers touch the palm, and this position cannot be corrected by any justifiable amount of force. As soon as the wrist-joint is bent to a right angle, the interphalangeal joints can readily be extended. In a very severe case the wrist itself will become markedly flexed, and it will be impossible to extend it. The forearm is usually semiflexed and the hand pronated. The ulceration or sloughing so frequently present is called a splint-sore. There is always marked induration about a splint-sore. The flexor muscles themselves are indurated and usually wasted. The condition of sensation depends upon the state of the nerves of the part. When neuritis is absent, sensation will be normal; but in accordance with the amount of neuritis and degeneration there will be hyperesthesia, partial anesthesia, or complete anesthesia. A curious feature of these cases that is dwelt upon by Dudgeon and commented upon by Turner is the fact that in young children there is a cessation of growth of the bone. Robert

Jones ("Am. Jour. Orthop. Surg.," April, 1908) reports that 19 cases out of 40 were associated with fracture. In 13 of the 19 cases there was pronounced malunion.

Treatment.—The old view of this condition was that it is practically hopeless. Anderson and Dudgeon, however, maintain that restoration may usually be obtained, the treatment consisting in regular, active motion, passive movement, massage, and electricity. Forcible extension under ether is of no benefit whatever.

Jones' plan of treatment is very beneficial ("Am. Journ. Orthop. Surg.," April, 1908).

Operative procedures on arms that necessarily have deficient circulation are hazardous, and Jones has discontinued all operative correction and relies upon purely mechanical and manipulative routine, as follows:

Five splints are cut out of zinc, tin, or sheet wire, to fit each finger and thumb.

The wrist is forcibly flexed and held while each finger is separately splinted. It

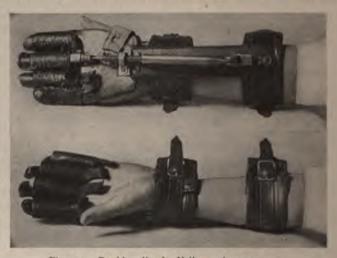


Fig. 392.—Rugh's splint for Volkmann's contracture.

will be observed that in the fully flexed position of the wrist the fingers are all relaxed.

When the finger splints have been applied the wrist is released, and the patient is directed to systematically extend the carpophalangeal joints. In a few days the second splinting may usually be employed by embedding the entire hand to the wrist and the already splinted fingers in plaster of Paris, while the wrist is again flexed. Several days are devoted to systematic voluntary efforts at extension of the hand in a similar manner employed for the metacarpophalangeal joints.

The third splinting embraces that already employed and in addition embraces the wrist in the fullest extension possible, which in a few days may be increased until full extension is obtained. The latter position of full extension of wrist, hand, and fingers is maintained for some weeks until all contractible elasticity has disappeared. Strains 731

It is usually observed that when the hand can be held in hyperextension without tendency to relapse, the circulation will almost invariably improve and the fingers resume their normal function and appearance except in cases of nerve destruction. Jones has found that in many cases where the nerves had lost their function during contracture, the extension of the hand was the starting-point of recovery.

R. H. Sayre ("Volkmann's Ischemic Paralysis and Contracture, Am. Jour. Orthop. Surg.," Nov., 1908, p. 221) advocates the Jones method in all cases, inasmuch as cutting operations may be employed later when the results of Jones' treatment are not entirely satisfactory. The improvement in the circulation and function obtained by the Jones method will make the operative

field more capable of rapid recovery.

In a persistent and long-continued case an operation may be necessary. The operation may consist in dividing in the forearm the flexor muscles of the fingers, as advised by Davies Colley, and then, at a later period, dividing the flexor tendons. The objection to his procedure is that it destroys the capacity to flex the fingers for all time. Another suggestion has been to excise a piece from both the radius and the ulna, and wire the fragments together. The best surgical treatment is probably exposing the nerves, separating them from adhesions, stretching them, and then doing tendon-lengthening, but this should not be done until all the improvement possible to secure by conservative treatment has been obtained by at least three months of effort.

Wounds and Contusions of the Muscles.—Wounds of muscles may be either open or subcutaneous. In a longitudinal wound the edges lie close together, and hence drainage must be provided for by the surgeon. In a transverse wound the edges separate widely, and catgut stitches must be inserted. Contusions of muscles, like contusions of other tissues, vary in extent and in severity. There are pain (which is increased by attempts to use the muscle), loss of function, swelling beneath the deep fascia, and discoloration, which may appear at once because of superficial damage from the initial injury, or which may appear in dependent parts after many days by gravitation of the blood and the blood-stained serum. As a result of contusion, suppuration, inflammation, or atrophy may arise.

Treatment.—In a longitudinal wound, drain; in a transverse wound, suture the muscle. The further indications in wounds and contusions of muscles are to obtain rest by means of splints and to secure relaxation. Limitation of swelling is secured by bandaging. Inflammation is combated first by cold and lead-water and laudanum; later by iodin, blue ointment, ichthyol, and intermittent heat. To prevent loss of function, employ, as soon as the acute symptoms subside, massage, passive motion, and stimulating liniments, and, later in the case, electricity (galvanism if the reactions of

degeneration exist; faradism, if absent).

Strains.—A muscular strain is a stretching of a muscle with a small amount of rupture. It is caused by traction in the long axis of the muscle. The muscle becomes swollen, tender, stiff, weak, and sore, and attempts at motion produce sharp pain. A strain of a tendon is a trivial or partial rupture. It leads to the development of acute thecitis, with fluid swelling and pseudocrepitation. Strains are common in the deltoid, the hamstring muscles, the back, the calf, the biceps, and the great pectoral.

Strain of the psoas muscle causes pain on voluntary flexion of the thigh, and is associated with tenderness in the iliac fossa. Strain of the right psoas may be mistaken for appendicitis, but it lacks the intense local tenderness, the abdominal rigidity, and the constitutional symptoms. "Lawn-tennis arm" is a strain of the pronator radii teres muscle. "Rider's leg" is a strain of the adductor muscles of the thigh. A strain of the long head of the biceps flexor cubiti produces the condition called by ball players a "glass arm." A strain may be the only injury, or may be associated with some other condition (fracture of bone, dislocation, sprain, contusion, etc.). A strain may be followed by periostitis at the point of insertion of the muscle. Atrophy of the muscle occasionally follows a strain.

A strained muscle is usually rigid, is tender, and pains greatly when an attempt is made to use it. The skin over it, especially over its point of inser-

tion, is usually tender.

A strain of the back is a very common accident which is often associated with sprains of the vertebral articulations. There is great pain when the patient voluntarily straightens up. If the vertebral ligaments are not damaged, the patient can be straightened by passive motion without pain. The skin is tender in certain areas. The muscles are often rigid. There may be unilateral rigidity. In a back injury make a careful examination to be sure no damage has been inflicted upon the vertebræ or cord.

Treatment.—Relaxation by suitable position; rest by the use of splints or by putting the patient to bed; bandages for compression; hot fomentations or a hot-water bag, and ichthyol. As soon as acute symptoms subside employ frictions and massage. If there is much pain after a strain, administer Dover's

powder, or even morphin.

Rupture of Muscles and Tendons.—Rupture of a muscle is announced by a sudden and violent pain and by loss of function, arising during powerful muscular contraction or strong traction in the long axis of a muscle. The rupture may be announced by a clearly audible snap (A. Pearce Gould). A distinct gap is felt between the ends; great pain develops on movement; there are tenderness, loss of power, and swelling. Rupture may be followed by atrophy, as is a contusion. Among the muscles which occasionally rupture we may mention the quadriceps, biceps, triceps, deltoid, plantaris, etc.

Rupture of the biceps flexor cubiti or its tendon is not very common; 72 cases have been collected (W. W. Keen, in "Annals of Surgery," May, 1905). It is much more common in men than in women. Loos's table of 66 cases contains records of only 2 women (Doane, in "Jour. of American Med. Assoc.," May 16, 1908). The rupture may be where the muscular belly passes into the lower tendon, through the muscular belly, in the muscular part passing either to the long or short head, or at the part where the muscular belly joins the long or short head. The tendon of the long head may be torn through or the long head may be torn from the glenoid cavity. The muscular portion is far more often injured than the tendinous. In rupture of the muscle belly a part of the muscle, in rupture of the long head the entire muscle, becomes soft and relaxed. In rupture of the belly there is a gap between the two portions and each portion causes a lump. In rupture of the tendon there are not two lumps with a gap between, but there will be a

single muscular lump. In rupture of the long head the muscular belly is much nearer the elbow than in health (Figs. 393 and 394). If rupture takes place at the lower part of the belly, the muscle passes toward the shoulder. Rupture of the long head of the biceps allows the humerus to pass somewhat forward and upward.



Fig. 393.-Author's case of rupture of the long head of the biceps.

Flexion with the forearm supinated is much less powerful than flexion with the forearm pronated (Hüter's sign).

In a case of my own in the Blockley Hospital the accident had occurred while carrying a heavy bucket. Forearm flexion was possible, but slow, feeble, partial, and incomplete. On flexion the short head contracted, but the muscular "bunch" of the belly was nearer the elbow than normally. Rupture of the plantaris muscle (coup de jouet; lawn-tennis leg) is an injury which is frequently not diagnosticated. It occurs during exercise (walking, bicycling, jumping, playing tennis) or is first complained of after exercise. It produces sudden pain in the middle of the calf, swelling, and often ecchymosis and inability to walk except with a rigid ankle and everted toes. Rupture of the quadriceps extensor femoris tendon results occasionally from force which in other cases fractures the patella. The rupture is just above the patella. The patient cannot extend the thigh and cannot walk or stand and there is severe pain. A gap can be felt just above the patella, unless it is hidden by synovial effusion, and the muscle is bunched above.

Treatment.—In limited rupture treat as a severe strain. In treating extensive rupture of an important muscle, when the ends are widely separated, expose by a septic incision, unite the divided ends with sutures of chromicized catgut (Fig. 100), and sew up the skin with silkworm-gut. Treat the part in any case by rest and relaxation and combat inflammation by appropriate means. Passive motion and massage are employed as soon as union is firm. In rupture of the quadriceps extensor femoris, operation should be undertaken,

because mechanical treatment gives frequently a bad result and confines the patient to bed for weeks. Rupture of the biceps requires incision and suture. In a case in the Blockley Hospital (Figs. 393 and 394) I operated and found that the long head with a portion of periosteum had been torn off from the glenoid cavity. A portion of the upper end of the tendon was cut away and the tendon was fastened to the short head by splitting and suture. Nine months later the result was perfect (Keen, in "Annals of Surgery," May, 1905). Rupture of the plantaris is treated at first by rest in a posterior splint and compression and later by massage and the use of an elastic bandage. The patient is allowed to walk with a cane in one week, but does not raise the heel for several weeks.

Hernia of Muscles.—When a tear takes place in a muscular sheath, a portion of the muscle protrudes. The treatment is incision, extirpation of the protruding mass of muscle, and suturing of the muscle wound and of the sheath.

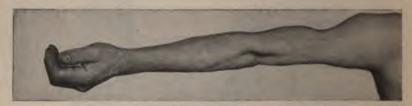


Fig. 394.-Author's case of rupture of the long head of the biceps.

Contractions of muscles may result from injury, from joint disease, from malposition of parts (as in old dislocation or torticollis), or from diseases of the nervous system. The treatment in some cases is sudden extension, in other cases gradual extension, tenotomy, or myotomy. Macewen recommends the making of a number of V-shaped incisions in the muscle. In some cases of spasmodic contraction nerve-stretching is of value.

Dislocations of Muscles and Tendons.—The long head of the biceps is oftenest displaced. The flexor carpi ulnaris, the peroneus brevis, the peroneus longus, the tibialis posticus, the sartorius, the plantaris, the quadriceps extensor femoris, and the extensors back of the wrist may be dislocated. What is known as dislocation of the latissimus dorsi, a condition in which that muscle no longer lies upon the angle of the scapula, is not a dislocation, but a paralysis. Most of these accidents are associated with chronic joint-disease or with fracture, but displacement may exist as a solitary injury. Dislocation of the long head of the biceps may occur tolerably early in the progress of rheumatoid arthritis of the shoulder-joint, and the displaced tendon may be absorbed.

Symptoms.—After dislocation of a tendon the muscle of the tendon can still contract, but it acts at a disadvantage; thus the corresponding joint exhibits partial loss of function. The displaced tendon can be felt, and a hollow exists where it normally resides.

When the muscle contracts, the tendon is felt to slip from its groove. When the tendon of the biceps is dislocated, the head of the bone passes forward (so-called subluxation of the humerus).

Treatment.—In tendon-dislocation reduction is easy, but the displace-

ment is apt to recur because of laceration of the sheath. The treatment usually advised is to effect reduction by relaxation of the limb and manipulation of the tendon, to place the part upon a splint so that the muscle belonging to the tendon will be relaxed, and to apply pressure over the point of injury. This treatment generally fails, and if the tendon does not become firmly anchored in its proper situation in four weeks, we should operate. In some tendons it is enough to incise, freshen the edges of the torn sheath, and sew up with kangaroo-tendon or chromicized catgut. In a tendon lying in a long groove make a halter for the tendon by incising the periosteum and suturing it over the tendon.\* Passive movements are begun at the end of the first week. Even if the tendon will not remain reduced, a useful joint will be obtained.

Wounds of Tendons.—Subcutaneous wounds of tendons are usually inflicted by the surgeon, and they heal well. Open wounds require rigid and isepsis and suturing of the tendon. In wounds of the wrist especially always suture the tendons (Fig. 101), and be sure to bring the proper ends in to apposition.

Rupture of Tendons.—A violent muscular effort may rupture a tendon, and as the accident occurs, a snap may often be heard. The symptoms are sudden pain and loss of power, fullness of the associated muscle from retraction, and absolute inability to bring the tendon into action. A gap may often be felt in the tendon.

Treatment.—The best procedure in treating rupture of a tendon is exposure by incision and the introduction of sutures. Some surgeons relax the parts and apply splints.

Thecitis, or tenosynovitis, is inflammation of the sheath of a tendon.

Acute thecitis may arise from a contusion, from a wound, from repeated overaction in working or while engaged in some sport, from rheumatism, from gonorrhea, from pyogenic infection, from influenza, from the continued fevers, or from syphilis. In early syphilis certain tendon-sheaths may rapidly develop effusion because of hyperemia of the sheaths (Taylor).

Symptoms.—In non-suppurative cases of thecitis the symptoms are pain, swelling, tenderness, and moist crepitus along the tendon-sheath, due to inflammatory roughening. The crepitus disappears as the swelling increases, but it reappears as the swelling diminishes. In suppurative cases (phlegmon of the lendon-sheaths) the symptoms are great swelling, pulsatile pain, dusky discoloration, inflammation spreading up the tendon-sheaths, and often the constitutional symptoms of sepsis.

Treatment.—In treating non-suppurative thecitis, employ splints and apply locally iodin, blue ointment, or ichthyol, and administer suitable remedies to combat any causative constitutional disease. In the suppurative form make free incisions, irrigate, drain, dress with hot antiseptic fomentations, and employ Bier's method (page 116). (See Felon, page 740.)

Palmar Abscess.—We mean by this term an abscess beneath the palmar fascia and not a superficial collection of pus. Palmar abscess may anse after wounds, abrasions, burns, or inflammations of the skin of the palm. A thecal abscess in a flexor tendon of a finger travels rapidly upward and may produce a palmar abscess. A thecal abscess of either the index,

<sup>\*</sup> Walsham's case of dislocation of the peroneus longus, Brit. Med. Jour., Nov. 2, 1895.

ring, or middle finger is usually arrested at the lower end of the palm, but suppurative thecitis of the thumb or the little finger conducts pus along the tendon sheath and up the arm (Fig. 396). If the theca ruptures, pus is diffused over the palm. It produces great swelling of the hand and fingers, the dorsum being swollen as well as the palm. The fingers become flexed and rigid. Violent pulsatile pain and decided constitutional disturbance exist. Discoloration is late in appearing. Adjacent lymph-glands enlarge. Palmar abscess is a most serious affection. The pus may dissect up all the structures of the palm, may pass between the bones and reach the dorsum, or may pass beneath the anterior annular ligament into the connective-tissue planes of the forearm. In some cases it leaves a clawed, stiff, and useless hand.

Treatment.—A palmar abscess demands radical treatment at the earliest possible moment; delay will be responsible for stiff and contracted fingers and hyperesthetic skin, resulting in a damaged and perhaps a useless hand. The patient should be placed under the influence of ether. The incision is made



Fig. 395.-Tuberculous thecitis (compound ganglion).

in the line of the metacarpal bone and, if possible, below the palmar arches. A line transverse with the web of the thumb is below the palmar arches. In an incision above this line try not to cut either arch; but if one be cut, at once take means to arrest the hemorrhage (page 450). In a severe case it may be necessary to make several palmar incisions, to open the tendon-sheaths on the flexor surface of the forearm above the wrist, and to make counter-openings in the back of the hand, and it is sometimes necessary to introduce tubes, and drain through and through the hand. After operation apply hot antiseptic fomentations and put the part upon a splint. Bier's passive hyperemia is very useful. When granulations begin to form, dry dressings are substituted for the hot moist dressing. It may be necessary to give morphin for pain, and stimulants may be needed. There is great danger of stiffness of the fingers occurring, the tendons becoming adherent to their sheaths. Hence passive movements are inaugurated as soon as granulations begin to form.

Chronic thecitis may follow acute thecitis, but may be due to injury, to rheumatism, to gummatous infiltration, to rheumatoid arthritis, or to tuberculous inflammation of a tendon-sheath. Chronic thecitis is commonest in the tendons of the fingers, the ankles, and the knees; it may spread to a joint or it may arise from a tuberculous joint. This condition causes very little pain. In ordinary non-tuberculous thecitis the part is weak, tender,

Ganglia 737

painful, and stiff, crepitates on motion, and is swollen. In tuberculous thecitis there is at first distention of the tendon-sheath with serum. The serum contains rice, riziform, or melon-seed bodies, and the wall of the tendon-sheath is here and there thickened and caseating. Later in the case the interior of the tendon-sheath becomes lined with tuberculous granulations and a tuberculous abscess may form. Rice bodies are sometimes fibrinous masses, are sometimes pieces of separated and dead recently formed fibrous tissue, and are sometimes masses of proliferating cells. In these tuberculous cases the swelling is firm or doughy when due to granulation tissue, but is fluctuating when due to fluid. Grating is marked. Tuberculous thecitis is most common about the wrist, constituting the so-called compound ganglion (Fig. 395).

Treatment.—Tuberculous cases are treated as follows: If there is a fluid effusion and no rice bodies, make a small incision, wash out with salt solution,

introduce some iodoform emulsion, and close the wound. In cases in which there are rice bodies, open the sheath, evacuate the conents, scrape the walls thoroughly, inject with iodoform emulsion, and close the wound. (If the annular ligament requires division, stitch it before closing the wound-Fig. 411.) In cases with extensive thickening apply an Esmarch bandage, make a large incision, and remove all infected tissue from the sheath, around the sheath, and from the tendon. In tuberculous thecitis Bier's method (page 240) may be of service and so may the x-rays. In ordinary traumatic thecitis use for the first few days rest associated with applications of ichthyol. Later employ hot and cold douches, massage and passive movements, strapping of the part, inunctions of ichthyol, and the hot-air bath. If effusion is persistent or rice bodies exist, make an incision and scrape the interior of the tendon-sheath. In rheumatic cases give anti-



Fig. 396.—Palmar synovial sheaths (vaginæ tendinum), normal adult type (Poirier and Charpy).

theumatic remedies and employ the hot-air bath. In syphilitic cases admin-

ister mercury and iodid of potassium.

Ganglia.—In connection with tendon-sheaths and joints simple ganglia may develop. They are small, tense, round swellings, which are firm, grow progressively though slowly, are painless when uninflamed, and contain a fluid of the appearance and consistence of glycerin-jelly (Bowlby). Ganglia are commonest upon the dorsum of the wrist and they occur especially in those who constantly use the wrist muscles. Ganglia are occasionally seen on the dorsum of the foot. Paget states that a simple ganglion is due to cystic degeneration of a synovial fringe inside a tendon-sheath, and that the fluid of the ganglion does not communicate with the fluid of the tendon-sheath. Other pathologists have maintained that a simple ganglion is a hernia of synovial membrane through a rent in a tendon-sheath, all communication between the

herniated part and the tendon-sheath being soon obliterated. The belief is now general that a ganglion is due to cystic degeneration of an area of connective tissue adjacent to a joint or a tendon, this area of tissue having been rendered extremely cellular by traumatism. A number of minute cysts form and they coalesce into one cyst. The cyst may form a secondary communication with the interior of a tendon-sheath or joint. Ganglia occasionally diminish in size or even disappear spontaneously. Compound ganglion is an old name for tuberculous thecitis.

Treatment.—A ganglion is treated by aseptic puncture with a tenotome, evacuation, scarification of the walls, antiseptic dressing, and pressure. An



Fig. 397.—Ganglion of extensor tendon-sheaths of the wrist.

old-time method of treatment was subcutaneous rupture brought about by striking with a heavy book. Duplay treats a ganglion by injecting a few drops of iodin through a hypodermatic needle. The cyst is not evacuated before injection. The parts are dressed antiseptically, and cure is obtained in one week. Recurrent ganglia, very large ganglia, and ganglia with very thick contents should be dissected out.

Felon, or whitlow, is a violent, rapidly spreading pyogenic inflammation of a finger or a toe which resembles cellulitis, and which is sometimes followed by gangrene of the soft parts or by necrosis of bone (Fig. 398). As a rule, an injury precedes the whitlow—an abrasion of the surface which admits pus-organisms or a contusion which creates a point of least resistance. The commonest seat of a felon is the last digit of a finger or the thumb. An abrasion of the surface at this point absorbs pus-organisms and the superficial lymphatics carry the bacteria directly inward, the microorganisms lodging, it may be, in the skin, in the subcutaneous tissues, in the tendon-sheath, or beneath the periosteum. The perpendicular direction of the fibers of the subcutaneous tissue favors this passage inward.

Felons are very rare in infants, but may occur in children. Women are more liable to them than are men. The fingers are much more prone to infection than are the toes, because they are more exposed to injury. Several fingers may be attacked at once or successively in persons of dilapidated constitution. Whitlow is most apt to occur and is most severe in persons broken down by disease, alcoholism, overwork, or worry. In certain cases of neuritis painless suppuration may arise. In syringomyelia painless jelons are common, and they are apt to be associated with necrosis of bone. Pain-

less and destructive whitlows constitute a characteristic part of Morvan's disease.

There are two forms of felons, the superficial and the deep.

Superficial Felons.—One form of superficial felon is between the cuticle and the true skin and is rarely followed by involvement of deeper parts. The infection is in the skin. The point of infection becomes dark red, swollen, painful, and tender. The epidermis is lifted up into a pustule by the sero-pus which forms, and a considerable area may be attacked before the spread of the process is arrested. The commonest form of superficial felon is subcutaneous suppuration, the pus collecting in the fibro-fatty pad at the palmar surface of the last digit (G. B. Mower White, in "Brit. Med. Jour.," Feb. 24, 1906). This form often spreads deeply. If the subcutaneous tissues only are involved, the symptoms are those of an ordinary cellulitis. There is severe pain, increased by motion, pressure, and a dependent position. Swelling and discoloration

are early and marked. Pus forms within forty-eight hours. Paronychia, or "ring around," is a cellulitis starting at the end or side of the digit, and involving the parts around and below the nail. The pus-organisms obtain entrance by means of an abrasion, a puncture, or an ulcerated "step-mother." Inparonychia pain is throbbing and violent; is increased by motion, pressure, or a dependent position; the skin is dusky red, but the swelling is slight. In about forty-eight hours pus forms in the superficial parts, the epidermis being



Fig. 398.—Deep felon, with sloughing of soft parts and necrosis

lifted into pustules or blebs, and pus may also form under the nail. A portion of the nail or the entire nail may be lost.

If the tendon-sheath becomes involved as well as the subcutaneous tissue, the symptoms are those of suppurative thecitis, with more marked discoloration of the skin.

Deep Felons (Fig. 398).—There are two forms of deep felon. One is a thecal abscess involving the flexor tendon-sheath, arising secondarily to subcutaneous suppuration and spreading widely. In suppurative thecitis of the three middle fingers the process seldom reaches the palm; in suppurative thecits of the theca of the thumb or little finger the pus may pass above the wrist and a true palmar abscess may form (Fig. 396). Another form is suppuration beneath the periosteum. This form is the so-called bone jelon. It is occasionally primary, but more often arises secondarily to suppurative thecitis or to subcutaneous suppuration. In some cases a deep felon involves most of the struc-

tures of the finger (periosteum, bone, tendon, tendon-sheath, and cellular tissue), and may destroy the digit or the finger. The bacteria causative of a deep felon are lodged in the deeper parts. The pain is agonizing, entirely preventing sleep, pulsatile in character, associated with excruciating tenderness, greatly aggravated by motion or a dependent position, and often extending up the hand and forearm. The skin is dusky red and edematous, and

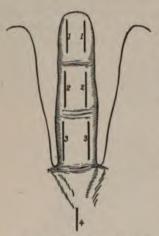


Fig. 399.—1, 2, and 3, Incisions for felon of finger and for ordinary suppuration; 4, palmar incision.

the part is enormously swollen. Pus forms quickly; diffuse cellulitis may arise; sloughing of the tendon and subcutaneous tissue may take place; necrosis of one or more bones may ensue, and in some cases gangrene of the finger follows.

In deep whitlow lymphangitis of the forearm and arm is not unusual, adenitis of the axillary glands is common, and almost always there is fever. In superficial felon constitutional symptoms are slight or absent, and lymphangitis and adenitis arise in a minority of cases.

Treatment.—In a subcuticular felon, after cleansing, soften the parts well in an antiseptic fluid and then pare off the cuticle with a very sharp knife. This plan of White's is an excellent one; it gives vent to pus and prevents the inoculation of the deeper tissues which may follow incision. In subcutaneous suppuration

incise the abscess, but be careful not to open the tendon-sheath or periosteum, as this would diffuse infection (White, in "Brit. Med. Jour.," Feb. 24, 1906). In neither of the above instances is it necessary to give an anesthetic. After operating the parts must be irrigated, dressed with hot antiseptic fomentations, the hand must be placed upon a splint, and Bier's passive hyperemia is to be induced daily. In a deep felon I am convinced that we should operate immediately. Allay tension and prevent pus-formation by early incision. Do not waste time with poultices; to wait means agonizing pain, sleepless nights, constitutional involvement, and, perhaps, sloughing of tendons or death of bone. Incision and drainage constitute the treatment, but incision conducted in a particular manner. I have only lately learned how to treat a deep felon. I formerly treated all cases by incisions down to the bone alongside of the tendon (Fig. 300) and was frequently disappointed by a spread of the suppuration in spite of incisions, by necrosis of bone, or by extensive sloughing of tendons. A few months ago I obtained new light upon this subject from an article on "Whitlow," by G. B. Mower White ("Brit. Med. Jour.," Feb. 24, 1906). I immediately put in practice the commonsense suggestions in this valuable article and have seen a surprising improvement in results. The chief points in White's plan of treatment are as follows: To plunge a knife through an area of infection into a tendon-sheath if that sheath is not infected will lead to infection, and the way to be sure whether it is or is not infected is to look through a carefully made incision and see. After careful sterilization, anesthetize, drain the extremity of blood by eleBursitis 741

vation, and apply an Esmarch band to the arm. This enables us to see what we are doing. Make an incision by the side of the tendon-sheath (Fig. 399), slowly and carefully, and on reaching it see if it is distended. If in doubt, insert a hypodermatic needle and withdraw fluid. If we get turbid serum, the theca is infected. If the theca is not infected, do not open it but incise the subperiostealarea of suppuration if it exists. If the theca is infected, remember that this infection has surely ascended more or less, and we must not only open at the lower point, but must also incise at the upper point. Do not incise the theca over the length of the tendon, as sloughing will follow. If one of the three middle fingers is involved, incise the distal end of the theca and also the proximal end over the head of a metacarpal bone in the mid-line, wash from opening to opening, and drain. If the theca of the thumb or little finger is involved, open distally and then proximally above the wrist. To reach the proximal end of the theca of the thumb cut at the radial side of the tendon of the flexor carpinal challs. Also open the palmar sac of the flexor longus pollicis, making the cut

along the inner border of the outer head of the flexor brevis pollicis.

To reach the proximal end of the theca of the little finger begin an incision at the upper margin of the annular ligament and carry it up along the inner border of the flexor sublimis. Retract the tendons and pus will usually be found between the tendons of the superficial and deep flexor. Look beneath the profundus tendons for the bursa and open it. Then open the palm by an in cision in the line of the axis of the ring-finger. Thus three openings are made in either case, and the theca can be thoroughly washed and drained. If either the thumb or little finger bursa is found infected, the other must be exposed and examined, as they usually communicate at their proximal ends or a communication may form as a result of suppuration. Rupture of either bursa may diffuse pus widely. White, in order to prevent secondary hemorrhage, ligates the radial artery in two places and removes 11 inches of it (if operating on the thumb bursa); and ligates the superficial arch and removes I inch of it (if operating on the palmar expansion of the little finger theca). These arterial ligations seem a serious and perhaps unnecessary addition to the operation and I have not practised them. After thorough irrigation apply antiseptic fomentations, splint the extremity, and induce Bier's passive hyperemia daily. If the patient cannot sleep, give morphin. See that the bowels are moved once a day. Give quinin, iron, and milk-punch. As soon as granulations begin to form, use dry dressings and make passive motion daily. If bone undergoes necrosis, let it loosen and then remove it. Amputation is sometimes necessary.

Bursitis is inflammation of a bursa. Acute bursitis arises from strain or from traumatism. The symptoms of acute bursitis are pain, limited swelling, moist crepitus, fluctuation, and discoloration in the anatomical position of a bursa. In chronic bursitis there is intermittent pain, tenderness, and progressive, fluctuating swelling. Bursitis of the retrocalcaneal bursa (Albert's disease) is a painful affection which is often overlooked. It is tather common in storekeepers who rise often on the toes to reach shelves, in motormen who use a foot gong, in street-car conductors, and clerks who stand at desks. It may follow gonorrhea. Walking causes great pain in the heel. Raising up on the toes is exceedingly painful. It is usually associated with flat-foot. In these cases osteophytes often form within the

bursa. There are numerous bursæ about the hip. Some anatomists co twenty-one.\* The two most important bursæ and the ones usually affect are the iliac and the deep bursa over the great trochanter.† Inflammat of the iliac or ilio-psoas bursa produces swelling below Poupart's ligame which swelling is tense, but exhibits fluctuation on careful examinate Often the swelling attains large size. In some cases the sac can be empt by pressure, the fluid passing into an adjacent bursa or into the joint. I swelling is beneath the femoral artery and consequently lifts that we (F. B. Lund, in "Boston Med. and Surg. Jour.," Sept. 25, 1902). The enlar ment often presses on the anterior crural nerve and causes spasmodic put throughout the nerve's trajectory. The limb, according to Zuelzer, is usu slightly flexed, abducted and rotated outward, and movement in an oppodirection causes pain. Inflammation of the bursæ about the hip may prod symptoms resembling those of incipient coxalgia, but in bursitis the symptom on tremit, as in hip-disease. Ilio-psoas bursitis occasionally results for



Fig. 400.—Olecranon bursitis.

gonorrhea. The bursa is someti involved in joint-disease. In inflmation of the iliac bursa flexion not so marked as in coxalgia, and trochanter is never above Nélat line. In inflammation of the o trochanteric bursa the position is same as in iliac bursitis, and res bles that of coxalgia. In coxal however, there is pain on press upon the front of the joint or dire on the trochanter or on tapping sole of the foot. These manip tions do not cause pain in bur (Zuelzer). In inflammation of gluteal bursæ there is moderate back of the thigh and knee, wl

disappears when the patient is at rest; there are a marked limp, limita of motion, and an area of deep fluctuation in the buttock (Brackett).

It is difficult to differentiate between inflammation of a deep bursa synovitis; indeed, in bursitis the joint is apt to be secondarily affected. It difficulty is especially vexatious in distinguishing between joint-injury injury of the bursa beneath the deltoid. Suppuration may take place bursa. Direct force may rupture a bursa. The bursa beneath the deltois frequently ruptured. When this accident happens, there are pain, may swelling, a large area of moist crepitus, and later extensive discolora from blood. Chronic bursitis may follow acute bursitis, or the disease be chronic from the start. It may be due to tuberculosis. Bursæ part larly apt to become tuberculous are those about the hip, the subdeltoid, olecranon, the prepatellar, and the retrocalcaneal. In tuberculous bur during the first stage the bursa is distended with fluid, due to oversecret the walls are thickened here and there, and perhaps contain caseous foci

<sup>\*</sup>Synnestvedt, of Sweden. †Zuelzer in Zeit f. Chir., vol. l.

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rice bodies are found in the bursal fluid. In a more advanced stage the bursal wall is lined with caseating granulation tissue and the bursa may become a



Fig. 401.-Housemaids' knee.



Fig. 402.—Bursitis of left olecranon bursa of three years' duration.

tuberculous abscess, the walls may give way with diffusion of the process, or mixed infection with pyogenic organisms may occur. In some cases of

tuberculous bursitis tending to cure the bursal walls become enormously thickened by fibrous tissue. The **symptom** of chronic bursitis is swelling with little or no pain unless acute inflammation arises. Chronic bursitis of the subhyoid bursa is known as *Boyer's cyst*.

Treatment.—Acute bursitis is treated by rest, pressure, and the application of iodin, blue ointment, or ichthyol. If the swelling persists, aspirate and apply pressure, or incise the sac and remove it partly or completely. If pus forms, incise, paint the interior of the sac with pure carbolic acid, and pack with iodoform gauze. Chronic bursitis may be cured by the use of pressure and the application of blue ointment, and with treatment of

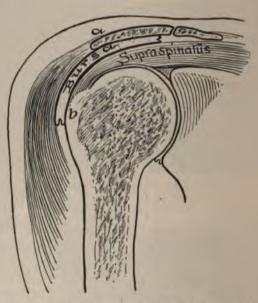


Fig. 403.—Diagram from a frozen section. Notice the deltoid and its origin, from the edge of the acromion. Notice the subdeltoid or subacromial bursa with its roof made by the under surface of the acromion and by the fascia beneath the upper portion of the deltoid. Its base is on the greater tuberosity and the tendon of the supraspinatus, which separates it like an interarticular fibrocartilage from the true joint (Codman).

any causative diathesis, but most cases require incision and packing. A ruptured bursa is treated as an acute bursitis. In bursal tuberculosis the best treatment is excision. If we are dealing with a very deep bursa, the proper treatment is incision, scraping with a sharp spoon, mopping with carbolic acid, and packing with iodoform gauze.

Bursitis of the subacromial bursa has been considered by A. E. Codman ("Boston Med. and Surg. Jour.," Oct. 22 and 29, Nov. 5, 12, 19, and 26, and Dec. 3, 1908), who points out that the deltoid and the subacromial bursa are one and the same thing. When the arm is abducted, the entire bursa is subacromial; when it is adducted, a large portion of the bursa is subdeltoid. Codman describes three types of conditions associated with inflammation of this bursa, first: The acute, or spasmodic type, in which

there is local tenderness on the point of the shoulder, just below the acromion process and outside the bicipital groove. In some cases Dawbarn has shown that the tender point, which is the base of the bursa, disappears under the acromion when the arm is abducted. Codman goes on to show that in attempting abduction about ten degrees of motion can be obtained without moving the scapula. Then the scapula is locked by spasm and moves with the humerus. This spasm may be temporary in mild cases. Sometimes pain prevents the patient from voluntarily raising the arm, though it may be raised by passive motion. The pain may run down the outer side of the arm, even into the hand; the patient frequently locates the pain about the insertion of the deltoid, and may be able to note swelling of the bursa.

Codman describes type two, the subacute or adherent type, in which there are adhesions between the roof and floor of the bursa and a definite mechanic hindrance to abduction and external rotation. There may or

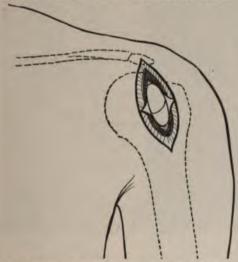


Fig. 404.—Showing incision used for demonstration of the bursa (Codman).

may not be local tenderness, but Dawbarn's sign is absent, owing to the presence of the adhesions. Abduction is limited to such a great degree that, as a rule, the tuberosity will not pass beneath the acromion. Any movement in abduction beyond ten degrees causes the scapula to move. The pain is located as in type one, and frequently also passes into the neck. In some cases it is very severe.

Codman's third form is the chronic or non-adherent. In this the full are of motion is retained, but motion is painful. The bursa is thickened and irregular. There may or may not be local tenderness; and if this is present, one will find Dawbarn's sign. Abduction and external rotation are limited little, if at all, but at some point during abduction there is severe lenderness, which disappears as soon as the tuberosity passes beneath the acromion. The scapula does not accompany the motions of the humerus. There is often considerable pain after motion.

Codman points out that the prognosis in type one is very favorable if treatment is correct. In type two the disability, even without treatment,

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seldom lasts more than two years. He says that even severe or adhe cases, if there are no secondary contractures in the forearm muscles, recover in from one to two years. In infective cases the prognosis is



Fig. 405.—Showing the abduction splint in position, the patient standing. It is by a figure-of-8 bandage, which crosses behind the shoulders and by a belt about the The arm is at rest (Codman).

Description of Splint.—The frame of the splint which I use is made of iron wire (dian inch), stiff enough to maintain its form and to carry the weight of the arm sec Sufficient cotton wadding to thoroughly pad it is bandaged over it and the whole co with cotton or linen cloth. The general shape is shown in the photograph. It shou just long enough to extend from the axilla to the seat of the chair on which the patien It is best held in position by a belt around the pelvis and a figure-of-8 flannel bandage the shoulders crossing back of the neck. A pad should be placed in the opposite axil prevent excoriation of the skin by the bandage.

During the first twenty-four hours and afterward, if worn at night, the arm should be lightly bandaged to the projecting part of the splint. Additional security is give the application of a swathe, which may be pinned to the bandage of the axilla.

When properly adjusted it is perfectly comfortable. Unless it is comfortable it is less. The use of the splint is not essential and is even harmful if not skilfully cared for

worse than in traumatic cases. In chronic cases, in which the arc of mol is not affected, the prognosis is fairly good.

Treatment.—Acute cases of subacromial bursitis should be treated keeping the arm abducted. Monks suggests that the patient may sit table, the arm being abducted and placed upon a pillow that is on the table.

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This relaxes the short rotators and the deltoid, and keeps the base of the bursa from being in contact with the acromion (Codman). At night Codman places the arm on a pillow, with its long axis at right angles with the patient's body as he lies recumbent. If the patient has to get about, he may use a sling most cautiously. He should take the arm out from time to time and rest it on a table. Massage should be used about the bursa, but not directly over it. In the more severe cases with adhesions one may employ massage, passive and active movements, baking, forcible movement and manipulation under an anesthetic, followed by fixation in the position of abduction, or perhaps incision of the bursa with division of the adhesions or excision of the subdeltoid portion of the bursa (Codman). In the cases in which there is irregularity of the surface of the bursa, one should excise and remove the thickened folds or other irregularities.

Housemaids' knee (Fig. 401) is thickening and enlargement of the prepatellar bursa, the result of intermittent pressure. In effusion into the knee-joint the fluid is behind the patella and the bone floats up; in housemaids' knee the fluid is above the bone and the osseous surface can be felt beneath it.

"Miners' elbow" (Fig. 402), which is a condition similar to house-

maids' knee, affects the olecranon bursa.

"Weavers' bottom" is enlargement of the bursa over the tuberosity of the ischium. A bursa which is simply thickened and enlarged rarely gives rise to annovance; but when it inflames, as it is apt to do, it causes the ordi-

nary symptoms of bursitis.

Treatment of Special Forms .-Some few cases of housemaids' knee may be cured by rest and blistering, but in most cases it is necessary to incise and pack with iodoform gauze. In enlargement of the bursa beneath the ligamentum patellæ, if rest and blistering fail to cure, aspirate or incise. In enlargement of the bursa beneath the tendon of the semimembranosus and also in "weavers' bottom" and in "miners' elbow," incise and pack. In Operating for ilio-psoas bursitis I follow Lund's advice and make a vertical incision below Poupart's ligament, and between the anterior crural nerve and the femoral artery. The fibers of the ilio-psoas muscle are separated and the bursa is opened and drained. Some few cases of retrocalcaneal bursitis recover after rest, but most of them require incision and drainage. If osteophytic formations exist, the bony stalactites must be removed by



Fig. 406.—Enlargement of the deep infrapatellar bursa, chronic, and the result of traumatism (Patterson).

means of the rongeur. Flat-foot, if it exists, is treated by a support (page 759).

Bunion.—A bunion is a bursa due to pressure, and it is most commonly situated above the metatarsophalangeal articulation of the great toe, but is

occasionally seen over the joint of another toe. When the big toe is put toward the other toes by ill-fitting boots, a bunion forms. When a bunion tinflamed, it may cause but little trouble; but when it inflames, the enlarges and the parts become hot, tender, and exceedingly painful. puration may occur and pus may invade the joint, and the bone not us ally becomes diseased.

Treatment.—In treating a bunion the patient must wear shoes the not pointed, that have the inner border straight, and that have routoes (Jacobson). For a mild case a bunion-plaster gives comfort, advises the use of a linen glove over the digits, the phalanges being of



Fig. 407.—Bigg's apparatus for bunions.

inward by a piece of elastic webbing, one end of is fastened to the glove and the other end to a pie strapping from the heel. A special apparatus m worn (Fig. 407). In many cases osteotomy of the phalanx or of the first metatarsal bone is require some cases excision of the joint is necessary; in a amputation must be performed. Charles Mayo operated on 65 cases successfully. He removes the of the metatarsal bone and with it two-thirds of the pertophy on the inner side, and turns the burse the joint area in front of the bone. He sutures this in place and now has a synovial membrane for a

which becomes satisfactorily movable ("Annals of Surgery," August, when the bursa is not inflamed, but only thickened, blisters should be ployed over it, or there should be applied tincture of iodin, ichthyol, or curial ointment. When the bursa inflames, ichthyol ointment is applied intermittent heat by foot-baths gives relief. Suppuration demands i diate incision and antiseptic dressing. If an ulcerated bunion does no by antiseptic dressing, stimulate it with nitrate of silver and dress it unguent, hydrarg, nitrat. (1 part to 7 of cosmolin). Jacobson recommiskin-grafting for some cases.

## OPERATIONS UPON MUSCLES AND TENDONS.

Tenotomy is the cutting of a tendon. It may be open or subcutar

the open operation being preferred in dangerous regions.

Open Division of the Sternocleidomastoid Muscle for Nameck.—Subcutaneous tenotomy for wry-neck has been largely aband. It is not only more unsafe than the open operation, but it never comp divides all the contracted band.

The instruments required consist of a scalpel, dissecting forceps, a static forceps, scissors, needles, ligatures, etc. The patient is placed rebent, the chin being drawn more than is habitual toward the opposite

A transverse incision is made over the muscle about one-fourth inch above the clavicle. The superficial parts are divided, the muscle exposed and sectioned, bleeding is arrested, and the skin is sutured, the anterior jugular vein, which is underneath the muscle, and also the nal jugular, which is close to the outer edge of the muscle. Mikulicz cates the removal of almost the entire muscle, leaving, however, the and posterior portion where the spinal accessory nerve passes. After

ration for wry-neck support the head with sand-bags or a plaster-of-Paris dressing until healing occurs, and then inaugurate motions, active and passive.

Subcutaneous Tenotomy of the Tendo Achillis.—This operation is performed for club-foot, in which the heel is raised. The tendon is cut about one inch above its point of insertion. The instrument used for the first puncture is a sharp tenotome. The patient lies upon his back, "with his body rolled a little toward the affected side" (Treves), the foot being placed upon its outer side on a sand-pillow. The surgeon stands to the outer side. The tendon is rendered moderately rigid, and a sharp tenotome, with its blade turned upward, is inserted along the anterior border of the tendon until the surgeon's finger feels the knife approaching the outer side. The sharp-pointed instrument is withdrawn and a blunt-pointed tenotome is inserted in its place. The tendon is drawn into rigidity, and the surgeon turns the blade of his knife toward the tendon, places his finger over the skin, and saws toward his finger. The tendon gives way with a snap. Treves states that a beginner is apt not to push the knife far enough toward the outside, or he may in the first puncture push the knife through the tendon; in either case the tendon is not completely cut. The little wound, which is covered with a bit of gauze, will be entirely closed in forty-eight hours. In club-foot cases after tenotomy some surgeons at once correct the deformity and immobilize the limb in plaster; some partially correct the deformity and apply plaster for one week, at which time they remove the plaster, correct the deformity further, reapply the plaster, and so on; other surgeons do not attempt correction of the deformity until the cut tendon has begun to unite, when they gradually stretch the new material.

Subcutaneous Tenotomy of the Tendon of the Tibialis Anticus Muscle.—The tendon is divided about one and a half inches above its point of insertion. It can be made tense by extending and abducting the foot. The sharp-pointed tenotome is entered upon the outside of the tendon, and is passed well around it. The blunt-pointed tenotome is used to cut the tense

tendon.

Subcutaneous Tenotomy of the Tendons of the Peroneus Longus and Brevis Muscles.—These two tendons are cut together back of the external malleolus, and one and a half inches above the tip of the malleolus, as to avoid the synovial sheath (Treves). The patient lies upon the sound side, the outer aspect of the deformed foot being upward and the inner aspect of the ankle of the deformed side resting upon a sand-pillow. A sharp tenotome is introduced close to the fibula, and is carried around the loose tendons. A blunt-pointed tenotome is now introduced, its edge is turned toward the tendons, and these structures are cut as they are made tense.

Subcutaneous Tenotomy of the Tendon of the Tibialis Posticus Muscle.—This tendon is sectioned above the point where its synovial sheath begins; that is, above the internal annular ligament (Treves). The tendon is made tense and the pointed knife is entered above the base of the inner malleolus. The knife is entered just back of the inner edge of the tibia, and is carried around the muscle and is kept close to the bone. The

tendon is sectioned with a blunt knife.

Subcutaneous Fasciotomy of the Plantar Fascia.—The contracted bands are discovered by motions which render them tense, and they

are divided just in front of the attachments to the os calcis. The sharp knife passes between the skin and fascia at the inner side of the sole of the foot. The fascia is cut from without inward by the blunt-pointed tenotome.

It is usually necessary to section the fascia at more than one point.

Tendon-suture and Tendon-lengthening.—The instruments required in these operations are an Esmarch apparatus; curved needles, and needle-holder; chromicized gut, kangaroo-tendon, or silk for an ordinary case, silver wire for a suppurating wound. In performing tendon-suture make the part aseptic and bloodless. It is wise to apply a rubber bandage on the proximal side, the bandage being applied centrifugally, forcing the proximal end of the tendon into view (Haegler). If searching for the proximal end of a flexor of the finger, flex the injured finger, and hyperextend the adjoining fingers (Filiget). If this expedient fails, enlarge the incision, or, what is better, make a large flap in the skin. After finding the ends approximate them, being sure the proper ends are brought into contact; stitch them together with a continuous suture or with one of the sutures shown in Fig. 408, 1, 2, and 3. In a suppurating wound suture by silver wire should be tried, though it usually fails. After suturing, remove the Esmarch apparatus, arrest bleeding, close the wound and dress it antiseptically, relax the parts, and place the limb on a splint. If, after suturing, there is much tension, stitch the cut tendon above the sutures to an adjacent tendon, and apply a splint, the finger which was injured being flexed, the others being extended

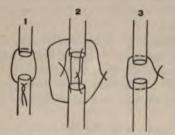


Fig. 408.—Tendon-sutures: 1, Of Le Fort; 2, of Le Dentu; 3, of Lejars.

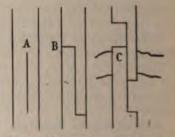


Fig. 409.—Anderson's method of tendonlengthening.

If only the distal end of the tendon can be found, graft it upon the nearest tendon with a like anatomical course and function. When a tendon has been sutured, begin gentle massage in two weeks. Positive passive motion is begun in three or four weeks. In old injuries, when the ends cannot be brought into apposition, lengthen one end or both ends, either by the method of Anderson (Fig. 409) or by the method of Czerny (Fig. 410). Dr. J. Neely Rhoads ("Med. News," Nov. 28, 1891) suggested that slight lengthening could be accomplished by "cutting half through the tendon at different levels and from opposite sides, leaving some longitudinal fibers to slip on each other, thus gaining slight elongation" (H. Augustus Wilson, in "International Clinics," vol. i, 4th series). Poncet makes several zigzag incisions on each side of the tendon, and when the tendon is pulled upon it elongates decidedly. Hibbs's method is shown in Fig. 412. One of these methods of lengthening may be used if there is deformity from tendon-contraction.

If the tendon cannot be lengthened sufficiently, make a bridge of catgut from one end of it to the other, or graft in another tendon from one of the lower animals, or graft the distal end to a tendon of like function (tendon-grafting).

The annular ligament is sutured as shown in Fig. 411.

Tendon-transplantation.—This operation is usually said to have been devised by Nicoladoni in 1882; as a matter of fact, Duplay did the operation in 1876, endeavoring to secure function in an arm rendered powerless by an injury (Eltings, in "Albany Med. Annals," April, 1902).

The first American surgeon to do the operation was Parrish, of New York, who in 1892 transplanted tendons in a case of club-foot. In some cases in

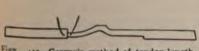


Fig. 410-Czerny's method of tendon-lengthening.

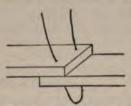


Fig. 411.—Method of suturing the annular ligament of the wrist.

which a muscle has been paralyzed surgeons have divided the tendon of the paralyzed muscle and have united its distal end with the tendon of a normal muscle, the normal tendon being split to receive it. It has also been stated that when a muscle or the tendon of a muscle is sutured to a paralyzed antagonistic muscle, the transplanted structure will actually execute the functions of the paralyzed muscle. For instance, a flexor, when so transplanted, may become an extensor and act under the mental impulse of extension; a pronator may become a supinator (H. A. Wilson in "American Med.," April 8, 1905). These principles have been utilized when some or many of the muscles of a limb have been paralyzed, the tendon of an unparalyzed muscle or the tendons of an unparalyzed group of muscles being fastened to the tendons of the paralyzed muscle. It has been shown that the success of this procedure depends upon the accuracy of diagnosis, the division of secondary contractures, the correction of existing deformities, and careful after-treatment. (See the article



Fig. 412.—Hibbs's method of tendon-lengthening.

by Dr. J. Hilton Waterman, in "Med. News," July 12, 1902.) In a paralysis of the lower extremity, as Goldthwait points out, the sartorius usually retains power, and it may be advisable in such a case to divide the sartorius and suture its upper end to the quadriceps above the patella. A strip of the tendo Achillis may be grafted upon the peronei in certain cases. An artificial tendon may be made of silk, the silk being passed from the sound to the paralyzed

tendon (Lange); the silk eventually becomes surrounded by fibrous tissue. Strands of silkworm gut may be used for the same purpose (Kummell). The operation of tendon-transplantation is occasionally of distinct benefit, but I agree with Ridlon, and am not usually sanguine of results. Ridlon wisely reminds us that in such cases much good may perhaps result from the proper use of braces, tenotomy, and hand stretching, followed by prolonged retention in plaster, the patient using his limb actively.

Ridlon points out that most brace treatment is not curative because it only aims to prevent deformity developing, and tenotomy and stretching fail because they only seek to remove existing deformity. The object should be some restoration of function. This is often obtained by following Thomas's direction and "posturing" the limb so as to permit structural shortening of

the paralyzed muscles and then fixing them for months.

# XXI. ORTHOPEDIC SURGERY.

This branch of surgery formerly dealt only with the treatment of deformities by means of mechanical appliances, but of recent years its domain has been enlarged to include the treatment, surgical and mechanical, of

deformities, contractures, and many joint-diseases.

Torticollis (wry-neck) is a condition in which contraction of certain of the neck-muscles causes an alteration in the position of the head. The disease is one-sided; the sternocleidomastoid is the muscle chiefly involved, though the trapezius, the splenius, and other muscles sometimes suffer. Acute torticollis, which is rare, is a temporary condition, and results from cold or from injury (see Myalgia). Chronic torticollis may be congenital (due to injury before birth or during birth), may be due to nerve-irritation, to an assumed attitude because of eye-defect, to polio-encephalitis (Golding Bird), to inflammation of the glands or to disease of the vertebræ, and it may be intermittent, but is usually persistent. The muscle stands out in bold outline, the head is turned to the opposite side, the ear of the disordered side is turned toward the shoulder, the chin is thrown forward, and spinal curvature may arise. The corresponding side of the face atrophies. There is no pain. In many cases the head may be restored to its normal position by passive movement or by voluntary effort, but it at once returns to its habitual position. Mikulicz asserts that torticollis is a chronic fibrous myositis, due often to compression during labor. He further says that the lesion known as hematoma of the sternomastoid, which occasionally follows labor, is not hematoma, but thickening due to myositis. D'Arcy Power reported the autopsy on a child one month of age. The sternomastoid muscle contained a fibrous mass, the result, Power believes, of a hemorrhage into the muscle prior to birth ("Med. Chir. Trans.," vol. lxxvi). Power, Clutton, and Owens have all traced cases of hematoma of the sternomastoid from early infancy to the time when tenotomy was required for torticollis. W. W. Richardson ("Surg. Gynec. and Obstet.," 1906) believes that interstitial myositis is always present, but doubts the causal influence of the lateral position of the head in utero. In some cases hereditary influence is evident. One woman gave birth successively to seven wry-necked children (Nove-Jusserand and Vianny, in "Revue D'Orthop.," 1906). In spasmodic wry-neck the muscle is thrown repeatedly into clonic contractions. In congenital torticollis the muscle and the cervical fascia are shortened, and the muscle does not relax under the influence of an anesthetic. In torticollis due to rheumatism and reflex causes the tonically contracted muscle relaxes when the patient is anesthetized.

Symptoms.—Congenital wry-neck is due to central nervous disease, to spinal deformity, or to injury during birth, and in this form the sternomastoid is shortened, hardened, and atrophied. It may not be noticed for some years because of the short neck of infancy. It is associated with assymmetrical development of the face, and is almost invariably upon the right side. Spasmodic wry-neck may present tonic spasm only, intermittent spasm alone, or both may appear alternately. It sometimes arises in those whose occupation demands frequent rotation of the head, but more often no such cause can be discovered. It is probably a disease of the cortical area which Presides over rotation of the head. (See article by C. A. Hamann, in "Buffalo Med. Jour.," Dec., 1901.) It is a disease especially of adults; in women it is often linked with hysteria. Pahl ("California State Med. Soc.," 1906) analyzed 68 reported cases. Men and women appeared equally liable, it was most frequent between the ages of twenty and thirty, and the right side was affected in twice as many cases as the left side. The exciting cause may be a cold, a blow, or a mental storm; the predisposing cause is the neurotic temperament. It may be due to enlarged glands, to carious teeth, or to eye-strain. In some rare cases bilateral spasm occurs, the head being pulled backward and the face being turned upward. Clonic spasms may come on unannounced, or they may be preceded by pain and stiffness; the head can he held still for a moment only; there is sometimes pain, always fatigue, but during sleep the contractions cease. The attack will probably pass away, but will almost certainly recur.

Treatment.—Congenital wrv-neck is treated by myotenotomy through an open incision in a line parallel to and just below the clavicle. The flaps are raised, access is free to both origins of the muscle, the muscle is readily divided, the wounds in the skin and fascia are closed. This incision leaves a trivial scar. After operation plaster of Paris is used to secure fixation and fixation is maintained from four to eight weeks. Early operation favors the establishment of muscular co-ordination before the development of permanent bony deformity of the vertebræ. Some surgeons cut the scalene muscles as well as the sternocleidomastoid. Gerdes Rowland lengthens the sternomastoid and carefully sutures it ("Practitioner," Sept., 1908). The old subcutaneous myotenotomy should be abandoned, as aseptic incision enables the surgeon to see and to feel all the contracted bands of fascia, muscle, and tendon, and to avoid vital structures (page 748). In spasmodic wryneck there is a fair chance of recovery. Pahl's table (Ibid.) shows that out of 68 cases, 28 recovered, 17 were improved, and 11 were not improved by treatment. Results in 12 were not stated. Treat the neurotic temperament and remove any obvious irritation (eye-strain, carious teeth, enlarged glands). Drugs usually are practically useless, although Chas. S. Potts reported a cure after the hypodermatic use of atropin. The rest cure is sometimes beneficial.

Tenotomy is not to be employed. In 1800 Mayo Collier suggested ligation of the spinal accessory nerve with silver wire. In persistent cases stretch or divide and exsect a part of the spinal accessory nerve (Keen). To reach this nerve, make an incision along the posterior edge of the sternocleidomastoic muscle, find the nerve as it emerges from under the middle of the muscle about one and a half inches below the tip of the mastoid process, retract the muscle at this point, and remove at least one inch of nerve. Neurectomy o the spinal accessory nerve paralyzes the sternocleidomastoid muscle, in spite of the fact that that muscle has also a nerve-supply from the cervical nerves The paralysis is followed by atrophy, and if the spasm affected the sterno mastoid muscle only, the operation will cure the case. Unfortunately, other muscles are usually involved, and cure will only be obtained by performing neurectomy on the nerves which innervate the affected muscles. For the treat

ment of rheumatic wrv-neck, see Myalgia (page 726).

Dupuytren's contraction is a contraction of the palmar fascia, of its digital prolongations, and of the fibers joining the fascia and skin. Fixed contraction of one or more fingers occurs. The ring-finger and the little finger most often suffer, but any finger or the thumb may be involved. The condition may be symmetrical. It is far more common in men than in women The disease arises oftenest in men beyond middle age, but is sometimes me with in youths. The cause of this disease is unknown; some refer it to gou or rheumatism or osteo-arthritis; others to traumatism, syphilis, organic nervous diseases, arteriosclerosis, reflex irritation, or neuritis. In one-fourth of the cases heredity seems to be influential. If due to traumatism, the righ hand should suffer most frequently; but it occurs in the left hand nearly a often as in the right (P. Jansen, in "Arch. f. klin. Chir.," Bd. lxvii, H. 4) Jansen examined specimens from 7 cases and found connective-tissue hypertrophy and circulatory disturbance, the contraction being a result of the above-named processes.

Symptoms.—Dupuytren's contraction is indicated by a small hard lump or crease which appears over the palmar surface of the metacarpophalangea joint. This nodule grows and the corresponding finger is gradually pulled down. In some cases the tip of the finger is forced against the palm. The

skin becomes dimpled or puckered.

Treatment.—Fibrolysin, which is a soluble combination of thiosinamin and salicylate of sodium, has been used hypodermatically in Dupuytren's contraction and, it is claimed, with success (Schwalbach). In treating Dupuy tren's contraction subcutaneous multiple incisions may be made, the tense fascia and the fasciocutaneous fibers being cut. The finger is straightened and is placed upon a straight splint, which is worn continuously for a week or ten days and is worn at night for at least a month. A more satisfactory operation is that of Keen. Keen divides the skin by a V-shaped cut, the base of the V being downward, lifts up the flap, and dissects out the contracted tissue. A cure is most certain to be obtained by Lexer's radical operation This surgeon excises the entire aponeurosis and considerable portions of the palmar skin adherent to the aponeurosis. In order to cover this wound i may be necessary to slide a pedunculated flap into the raw surface.

Syndactylism (webbed fingers) is always congenital, and may persis

through several generations. Simple incision of the web is useless; the operation to be performed is that of Agnew or of Diday (Figs. 413, 414).

In Agnew's operation a flap of skin from the dorsum is inserted between

the fingers and sutured in place.

In Diday's operation a flap is taken from the dorsal surface and another flap is raised from the palmar surface, and each flap is sutured to the finger

from which it springs.

Polydactylism (supernumerary digits) is always congenital, is often hereditary, and is usually symmetrical. There may be an incomplete digit, or there may be an entire and well-developed finger or toe with a metacarpal or metatarsal bone. The connection to the metacarpus or metatarsus may be by a fibrous pedicle only. If the digit is complete, with a metacarpal bone, no operation is required; if it is incomplete or is ill-developed, it should be removed.

Trigger-finger or Jerk-finger (Lock-finger, Snapping-finger).

—The patient can usually close the fingers, but on trying to open them one finger remains closed. It can be opened by grasping it with the other hand, but flies open with a snap, like opening a knife (Abbe). In some cases two



Fig. 413-Agnew's operation for webber fingers (Pye).



Fig. 414.—Diday's operation for webbed fingers (Pye).

fingers are involved. In a reported case (Frederick Griffith, "Annals of Surgery," 1904) the ring and middle fingers of the left hand locked at the knuckle-joints on attempting flexion. The locking occurred when about onethird the amount of flexion necessary to grasp an object was achieved. By bending the fingers with the other hand unlocking was accomplished and lexion was finished voluntarily. In attempting extension blocking occurred at the same point and unlocking was accomplished in the same manner. In most cases, but not in all, there is pain when locking occurs. The condition 15 gradual in onset. Trigger-finger is often associated with rheumatism (in 52 cases out of 121, according to Necker). It is said by Tubby to be due to enargement of the flexor tendon, or to contraction of the groove in the transverse ligament in the palm. It may be due to a ganglion, enchondroma, or enosynovitis. Traumatism or irritation may produce it. The tendon-sheath may be thickened or, according to Marcano, there may be a nodule on the lendon which rubs against the sesamoid bone. It may result from occupation.

Treatment. —If a ganglion, a loose cartilage, or a tendon nodule exists, treat by excision. A sesamoid bone may be excised. If there is inflammation, use massage and counter-irritation. If there is no obvious cause, put a compress over the tunnel in the ligament and apply a splint.

Mallet=finger.—This is called also drop-finger and rupture of extensor tendon. It is due to a blow in the direction of flexion whe finger is extended. It is supposed to be due partly to stretching and pto rupture of the extensor tendon at the point at which it is the posligament of the distal interphalangeal joint. Abbe has shown that bar players are liable to a condition which is the reverse of this, in which last phalanx is dislocated backward. Drop-finger is treated by in and suture of the tendon to the periosteum.

Genu valgum (knock-knee) results from an unnatural growth a internal condyle, causing the shaft of the femur to curve inward an internal lateral ligament of the knee-joint to stretch, the knees coming together and the feet being widely separated. This deformity is unnoted when the child begins to walk, but it may not appear until pu



Fig. 415. -Club-hand.

or even long after. K knee may arise from ri from an occupation der ing prolonged standin from flat-foot. It may in one knee or in both l

Treatment.-Mild tic cases of knock-knee remain in slight defor or may get well from provement of the ge health. In ordinary simply treat the rickety dition. The patient is bidden to stand or to and the limb, after bein as straight as can be, is on an external splint : pad is put over the inner dyle. Later in the plaster-of-Paris is Some surgeons prefer t mobilize while the leg is

to a right angle with the thigh. In a severe case the surgeon can imprize after forcibly straightening (causing an epiphyseal separation) or the performance of osteotomy (page 699). Osteotomy is preferable to ture by a mechanical appliance (osteoclasis).

Genu varum (bow-legs) is the opposite of knock-knee. Usually legs are bowed out, the knees being widely separated, the tibiæ and fe as a rule, being curved, and the feet being turned in. This disease in life is due to rickets, the weight of the body producing the deformity older people incurable bow-legs may arise from arthritis deformans.

Treatment.—Some mild cases of genu varum recover as a resimprovement in the health. Ordinary cases are treated by braces, by pl of-Paris bandages, and by attention to the general health. When the have hardened in severe deformity, osteotomy is necessary.

Club=hand (Fig. 415).-A congenital deformity in which the hand

Talipes

ates from the normal relation to the forearm. It is usually associated with other deformities. In some cases the radius and possibly some of the carpal bornes are absent.

Treatment.—By massage and passive motion, by immobilization, by

Talipes (club-foot) is a permanent deviation of the foot into deformity. There are several forms. Talipes equinus (Fig. 416) is a confirmed extension; talipes calcaneus (Fig. 417) is a confirmed flexion; talipes varus is a confirmed adduction and inversion; and talipes valgus is a confirmed abduction and eversion. Two of these forms may be combined, as in talipes equino-varus (Fig. 418, talipes equino-valgus, talipes calcaneo-varus, and talipes calcaneo-valgus. The causes of talipes are congenital or acquired. The congenital form is due to persistence of the fetal form of the foot. Acquired cases may arise from infantile paralysis, from spastic contractions, from Catrices, from traumatisms, from arrest of bony growth following upon the inflammation of bone, or from hysterical contractures.



416.—Talipes uinus (Albert).



Fig. 417.—Talipes calcaneus (Albert).



Fig. 418.—Double equino-varus ("American Textbook of Surgery").

Talipes equinus is rarely congenital. In this condition the patient walks

Talipes Calcaneus.—The patient walks upon the heel and cannot bring the toes to the ground. The true form is seen in congenital cases, the flexors of the foot being shortened, and the tendo Achillis being lengthened.

Talipes varus is rarely met with without equinus. In this condition the Patient walks on the outer edge of the foot.

Talipes valgus is met with in flat-foot. The patient walks on the inner edge of the foot.

Talipes equino-varus.—The heel is raised and the patient walks upon the outer edge of the foot. This is the usual congenital form.

Talipes equino-valgus is very rarely congenital. The heel is raised and the patient walks upon the inner side of the foot.

Talipes calcaneo-varus is a combination of calcaneus and varus.

Talipes calcaneo-valgus is a combination of calcaneus and valgus.

Treatment.—In congenital cases the condition is usually manifest on both sides, and is nearly always talipes equino-varus. Congenital club-foot should be treated in infancy, and when a restoration to position can be effected by the hands of the surgeon, is treated by plaster-of-Paris bandages. If a child has begun to walk, it may still be possible to correct the deformity

eventually by manipulations, by plaster-of-Paris bandages, or by club-foot shoes, but most cases require tenotomy of the tendo Achillis before the application of the shoe or the plaster. The club-foot shoe may do good service, but in many instances it is painful and is not so efficient as plaster-of-Paris. In severe cases, before applying the plaster, the patient is given ether; the surgeon cuts the tendons of the anterior and posterior tibial muscles, the plantar fascia, and the tendo Achillis, in the order named, and forcibly corrects the deformity. In old cases, with alteration in the shape of the bones, cuneiform osteotomy, or the removal of the cuboid or other tarsal bones, may be indicated. In these cases Phelps advises an open transverse division of all rigid plantar soft parts. Buchanan employs subcutaneous division of all resistant structures. Occasionally in relapsed and inveterate cases astragalectomy is performed. It is seldom practiced upon young children. (See page 719.) In some cases of talipes calcaneus shortening of the tendo Achillis is advised; but such an operation is only of temporary value, as stretching occurs after two years or more. In talipes due to infantile paral-



Fig. 419.—Print of a normal foot-sole (A) and of a flat foot-sole (B) (Albert).

ysis the operative treatment is the same, but we should not immobilize in plaster but rather in some apparatus which can easily be removed to permit the use of massage and electricity. In paralytic cases tendon-transplantation is occasionally employed. This consists in dividing the tendon of the paralyzed muscle and attaching its distal end to the adjacent tendon of a healthy muscle. (For full consideration see a work on orthopedic surgery.)

Pes planus (flat-foot) is a condition in which there is loss of the arch of the foot, due to muscular paralysis or ligamentous weakness, to prolonged standing, or to trauma. Flat-foot is especially apt to occur in rickets. Spurious flat-joot, or inflammatory flat-joot, occurs in Pott's fracture and in inflammation of the ankle-joint

or of the tendon of the peroneus longus muscle. Paralytic flat-joot is seen after infantile paralysis. Static flat-joot is due to disproportion between the body weight and the support of that weight. All children are born with pronated feet; the arch usually begins to form soon after birth, but in some individuals it never forms. Flat-foot, according to de Vlaccos, is thus produced: If we suppose a straight line prolonged downward from the center of the leg, most of the astragalus and os calcis will be external to it; hence the body weight presses on the inner side of the foot, and tends to flatten the arch and cause outward rotation, tendencies which are antagonized by the flexors of the toes and by the tibialis posticus muscle. The os calcis is pronated and is pushed to the side, the astragalus moves after the os calcis, and the ligaments are stretched ("Rev. de Chir., Aug., 1901). Pes planus is productive of much pain upon standing or walking in fact, the individual may be completely crippled. Pain is quickly relieved upon sitting down. Walking upon the toes is not painful. A marked flatfoot can at once be recognized by wetting the sole of the patient's foot with a colored fluid and causing him to step firmly upon a piece of paper (Fig 419, A, B). Beginning flat-foot cannot be thus recognized and is frequently overlooked, the patient being treated for gout or rheumatism. Even a sligh case can be detected by carefully observing the inner surface of the foot

When weight is placed upon it, it is seen to descend as the arch falls. A more accurate method is measurement, to find the middle of the foot. In flatfoot the extremity is lengthened. Golding-Bird points out that the middle of the normal foot is the point of articulation of the inner cuneiform and the metatarsal bone of the great toe. In flat-foot the greatest change is in the posterior half of this line. The extent to which the posterior measurement exceeds the anterior is the degree of flat-foot. The excess may reach three-fourths of an inch.

Treatment.-In paralytic flat-foot, which arises from infantile paralysis, employ exercise, electricity, and massage. To maintain a correct position of

the ankle and to facilitate normal muscular action, apply suitable braces. In some cases of paralytic flat-foot it is advisable to permanently stiffen the ankle-joint by operation. Operation is not indicated before the twelfth year, because during the earlier years of life union will probably fail to occur. Goldthwait removes the cartilage from the articular surfaces of the astragalus, calcaneus, tibia, and malleoli, and seeks to obtain permanent bony ankylosis. In static flat-foot it has long been customary to advise rest in bed for two weeks, and then exercise for several hours a day to increase arch. The usually recommended exercise has been to rise upon the toes again and again, the Datient resting for a time after each séance of exercise by sitting tailor-fashion with the legs crossed under him. Massage is ordered and a shoe is made containing a piece of steel so ar- Fig. 420 .- X-ray of hammertanged as to raise the arch of the foot. The patient's general health is, of course, attended to.



toe.

Orthopedic surgeons have come to regard this usual treatment as unphilosophical and improper.

In static flat-foot it is essential to understand that a flat-foot may be a fully functionating foot, free from pain and disability, and, therefore, not a subject for treatment. For convenience, flat-foot is divided into rigid and flexible. Either form may or may not be painful. The pain of flat-foot is usually the result of excessive use. It must be differentiated from Albert's disease, achillodynia, metatarsalgia, osteophytes on the under surface of the os calcis, and Raynaud's disease. Rigid flat-foot can be made flexible by manipulative measures or by the employment of H. Augustus Wilson's flat-foot correction screw (see Fig. 421). This apparatus pulls down on the posterior part of the os calcis and the distal extremities of the metatarsal bones and pushes up beneath the tarsus. The force employed is very great and much care should be exercised when it is used upon a patient under anesthesia It is preferable to use it without ether, relying upon the patient to state when the pressure becomes unendurable. A flexible flat-foot is capable of restoration of the lost muscular control by applied physical culture. Each toe and then the foot muscles should be developed to the maximum, so that the muscular control of the foot becomes almost as good as the muscular control of the hand.

It was formerly customary to prescribe various forms of steel plates to correct the broken-down arch, but orthopedic surgeons are discouraging their

use, as they destroy the muscular control of the foot, and by weakening the foot render it susceptible to sprains and other injuries. When necessity demands the employment of arch supporters, they should be used exactly like splints for fractures. They should be kept on constantly, day and night, for the shortest possible time and laid aside as quickly as possible. Three weeks is entirely too long for them to be used continuously, as in that time they are capable of causing such muscle wasting that months may be required to obtain muscular re-establishment. In cases of flat-foot that are incapable of muscular reconstruction, H. Augustus Wilson ("Amer. Medicine," May 6, 1905, p. 725) advocates the employment of the method devised by Prof. Dr. E. Müller ("Central. f. Chir.," January 10, 1903, p. 40) for paralytic valgus. It consists of an arthrodesis of the astragaloscaphoid joint, and transplantation of the tendon of the extensor proprius hallucis into a hole drilled free from above downward through the scaphoid. Fixation in plaster of Paris in an overcorrected position for four weeks almost invariably results in full



Fig. 421.-H. Augustus Wilson's flat-foot correction screw.

correction and normal function. The anterior tibial tendon is supplemented in its action by the transplanted tendon. Toe drop does not occur because the lesser extensor of the big toe assumes unusual power in raising the toe.

Gleich shortens the foot and raises the arch by sawing through the os calcis and fastening the posterior part of this bone at a lower level. Trendelenburg advises supramalleolar osteotomy. This operation permits of adduction and the adducted foot should be put up in an immovable dressing of plaster of Paris. Ogston resects the astragaloscaphoid joint. Golding-Bird and Davy remove the scaphoid bone. Stokes removes a wedge-shaped piece from the head and neck of the astragalus.

Pes cavus (hollow foot) is an increase in the arch of the foot, due, possibly, according to Golding-Bird, to paralysis of the peronei muscles. When the peronei muscles are paralyzed, the adductors act unopposed, and secondary contraction of the plantar fascia occurs. Certain it is that a contracted plantar fascia is the chief obstacle to correction. In many cases the cause is the wearing of shoes which are too short for the feet. The pressure made upon the toes causes spasm of the plantar flexors and this spasm permits the fascia to contract.

Treatment.—A shoe is worn containing a plate of steel in the sole, and pressure is applied over the instep. Tenotomy, division of the plantar fascia, or excision of bone may be required. In paralytic cases apply electricity

and massage to the paralyzed muscles.

Hallus valgus, or varus, a displacement of the great toe outward or inward, may occur in the young, but it is most frequent in old persons, especially old women. It arises often from wearing pointed shoes, shoes that are too short, or high heels, but may be due to gout or to rheumatic gout. In many cases an exostosis forms in the inner portion of the distal end of the metatarsal bone. In hallux valgus a bunion (bursa) is apt to form over the metatarsophalangeal joint and it may inflame or ulcerate.

Treatment.—An arrangement may be worn to straighten the toe and to protect the bunion (Fig. 407). The prominent and hypertrophied inner Portion of the head of the metatarsal bone may be removed by means of a chisel, osteotomy may be performed upon the metatarsal bone, the joint may be excised, or amputation may be required. H. A. Wilson advocates lateral excision. By means of bone-forceps he cuts away that part of the distal extremity beyond the phalanx, and with a chisel removes the remaining sharp line edge. He places the phalanx in normal position and holds it so for two weeks ("Am. Jour. Orthopedic Surgery," Jan., 1906).

Hammer-toe (Figs. 420 and 422) is a condition in which there is flexion one or more toes at the first interphalangeal joint. Shattuck shows that this condition is due to contraction of "the plantar fibers of the lateral ligaments of the joint."\* This disease usually begins in youth and may be congenital.

Dunion is apt to form, and the joint may become dislocated.

Treatment.—Terrier's plan of treatment consists in making a dorsal flap, removing a bursa if one is found, dividing the extensor tendon, opening the articulation, removing each articular surface with cutting forceps, suturing

the soft parts, and applying a plantar splint for two weeks.† Some surgeons excise the joint,

amputation of the toe is the best treatment.

Metatarsalgia (Morton's Disease).—This disease was first described by Dr. Thomas G. Morton, of Philadelphia, in 1876. It is a painful condition of the foot, Fig. 422.-Hammer-toe. due to jamming of a nerve between the heads of the fourth



and fifth metatarsal bones. The head of the fifth metatarsal bone is, by lateral pressure, forced against and below the neck of the fourth metatarsal, and as a result the superficial branch of the external plantar nerve and its two digital branches are squeezed. It is usually associated with flat-foot. Pain is produced by walking, and the suffering may be so severe that the patient is obliged to sit down at once. When the shoe is removed and the foot is rested, the pain soon abates. The pain is felt on the outer and inner sides of the little toe, the outer side of the fourth toe, and about the head of the fifth and the neck of the fourth metatarsal bones. Pain can be developed by grasping the foot in the hand and squeezing it. If flat-foot exists, there is also pain due to this trouble.

Treatment.-Mild cases may be cured occasionally by wearing wellfitting shoes and employing massage. Some cases require a brace. Severe cases demand resection of the fourth metatarsophalangeal joint, or amputa-

<sup>\*</sup>American Text-Book of Surgery,

tion of the fourth toe, and with it the head of the fourth metatarsal bone. Graham, of Washington, has cured cases by excising a portion of the super-

ficial branch of the external plantar nerve.

Coxa Vara and Coxa Valga.—Coxa vara (incurvation or infraction of the neck of the femur) is a disease characterized by bending of the neck of the femur, the femoral neck being depressed below its normal obtuse angle with the shaft, the hip-joint being perfectly healthy, and the condition, as a rule, being unilateral, but sometimes bilateral. This condition was described by Müller in 1889. Coxa vara is first noticed, as a rule, between the thirteenth and twentieth years, and the commonly accepted view has been that the deformity is rachitic, but Kredel has reported two congenital cases.\* Traumatic coxa vara may follow impacted fracture of the neck of the femur in a child. An individual with coxa vara develops a limp, and grows tired after slight exertion, but there is no swelling, no tenderness, and little or no pain. Shortening after a time becomes apparent, and the great trochanter can be detected above Nélaton's line. The extremity is adducted, and usually rotated outward. Abduction is limited. In some cases in which there is joint irritation all joint motions may be distinctly limited.

In a bilateral case there is lordosis, but shortening may not be detected because both legs are the same length. Each great trochanter, however, is

above Nélaton's line.

Coxa valga is a condition in which the angle of the neck to the shaft of the femur is more obtuse than normal. The neck may assume a position in line with the long axis of the shaft. It occurs particularly in children who have had infantile palsy, but it may be congenital, may occur in rickets and osteomalacia, and after a prolonged period of disease of a limb. The patient has pain and a limp, the extremity is lengthened, abducted, and in external rotation there is limitation of adduction and the trochanter is flattened. Coxa valga is usually unilateral, but may be bilateral.

The differential diagnosis in coxa vara and coxa valga is often very difficult, and the accompanying table will materially aid in contrasting the conspicuous features of the various conditions with which these two deformities of the neck of the femur may be confounded:

	HIP DISEASE.	INFANTILE PARALYSIS.	CONGENITAL DISLOCATION.	PSOAS ABSCESS,	COXA VARA OR VALGA.	KNEE DIS-
Age. Onset, Pain.	Four to six. Insidious. Referred to knee.	Four to six. Sudden. None.	Any age. From birth. None.	Four to six. Insidious. Referred to abdomen.	Any age. Childhood. None.	Four to aix. Insidious. Referred from knee.
History.	TB.	Inflammatory		ТВ.	Limp.	TB.
Posture.	Flexion, abduction, external ro- tation.	disease, Uncontrolled.	birth. Shortening.	Flexion, adduction, external ro- tation.	Great trochanter higher.	Knee flesed.
Muscular rigid- ity.	Present in all	Absent.	Absent.	In one direc-	None.	About knee.
Temperature. Local tender- ness.	i degree high. In hip.	Normal. None.	Normal. None.	tion. 1 degree. In spine.	Normal. None.	r degree. In knee.
Night cries. Tendency to abscess.	Present. Yes.	Absent. No.	Absent. No.	Present. Yes.	Absent.	Present. Yes.
X-ray.	Diseased focus in hip.	Atrophy.	Alteration in joint.	Normal hip.	Alteration in neck angle.	Normal trip, focus in knee.

<sup>\*</sup> Centralbl. f. Chir., Oct. 17, 1896.

The x-rays show the deformed bone in either coxa vara or coxa valga.

Treatment. - In coxa vara, as long as bending is progressing, employ rest. When the bone hardens, it may be necessary to perform osteotomy below the trochanters. In coxa valga Galeazzi performs osteotomy through the neck of the femur and allows the trochanter to ascend.

Flail-joints.—After an attack of infantile paralysis involving the entire lower extremity of each side the limbs become limp and swing flaillike when the extremity is made to move, and the joints are much relaxed. In such cases the psoas and iliacus muscles are never completely paralyzed, and the aim of the surgeon is to utilize these muscles in enabling the patient to walk. In many cases the application of apparatus is sufficient. In others ankylosis may be established in the ankles and knees by operation. If ankylosis is established in these joints, the psoas and iliacus muscles become able to move the legs.

### XXII. DISEASES AND INJURIES OF NERVES.

DISEASES OF NERVES.

Neuritis, or inflammation of a nerve, may be limited or be widely distributed (multiple neuritis). The first-mentioned form will here be considered. The causes of neuritis are traumatism, wounds, overaction of muscles, gout, rheumatism, syphilis, fevers, and alcoholism.

Symptoms.—The symptoms of neuritis are as follows: excessive pain, usually intermittent, in the area of nerve-distribution. The pain is worse at night, is aggravated by motion and pressure, and occasionally diffuses to adjacent nerve-areas or awakens sympathetic pains in the opposite side of the body. The nerve is very tender. The area of nerve-distribution feels numb and is often swollen. Early in the case the skin is hyperesthetic; later it may become anesthetic. The muscles atrophy and present the reactions of degeneration; that is, the muscles first cease to respond to a rapidly interrupted, and next to a slowly interrupted, faradic current; faradic excitability diminishes, but galvanic excitability increases. When, in neuritis, faradism produced no contraction, a slowly interrupted galvanic current which is so weak that it would produce no movement in the healthy muscle causes marked response in the degenerated muscle. In health the most vigorous contraction is obtained by closing with the - pole; in degenerated muscles the most vigorous contraction is obtained by closing with the + pole. When voluntary power returns, galvanic excitability declines; but power soften nearly restored before faradic excitability becomes manifest (Buzzard).

Treatment.—The treatment of neuritis consists of rest upon splints and the use of an ice-bag early in the case and a hot-water bag later. Blisters over the course of the nerve are of value, especially in traumatic neuritis. Massage and electricity must be used to antagonize degeneration. A descending galvanic current allays pain to some extent. Deep injections of chloroform or cocain may allay pain. Treat the patient's general health, especially any constitutional disease or causative diathesis. The salicylate of ammonium or phenacetin may be given internally. In some cases nerve-stretching

is advisable.

Neuralgia is manifested by violent paroxysmal pain in the trajectory of a nerve. This disease, unless it is exceedingly severe and persistent, is treated, as a rule, by the physician. Injections of alcohol or osmic acid into the nerve may secure relief or cure. If neuralgia is due to adhesions about the nerve

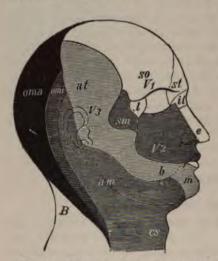


Fig. 423.—Distribution of the cutaneous sensitive nerves upon the head: oma, omi, The occipit. maj. and minor (from the N. cervical. II and III); cs, am, N. auricular magn. (from N. cervic. III); cs, N. cervical. superfic. (from N. cervic. III);  $V_1$ , first branch of the fifth (so, N. supraorbit.; st. N. supratrochl.; st, N. infratrochl.; e, N. ethmoid.; t, N. lachrymal.);  $V_2$ , second branch of the fifth (sm, N. subcutan. malæ seu zygomaticus);  $V_3$ , third branch of the fifth (at, N. auriculo-tempor.; b, N. buccinator; m, N. mental.); B, posteriof branches of the cervical nerves (Seeligmüller).

or to the pressure of scar or callus, these conditions should be amended surgically. There is some evidence that neuralgia arises, at least occasionally, from dilatation of the vessels of the sheath and subsequent edema and exudation. If this be the case cure may follow opening the sheath and separating adhesions between the sheath and nerve (Robert M. Simon, in "Brit. Med. Jour.," April 10, 1909). Neuralgia of stumps and scars is a surgical condition, and is due to neuromata, or entanglement of nerve-filaments in a cicatrix. Tic douloureux and other intractable neuralgias require careful removal of any cause of reflex irritation. Causal reflex irritation may arise from disease of the stomach, eyes, teeth, uterus, nose, throat, etc. Tic douloureux has been treated by removal of the Gasserian ganglion; intracranial neurectomy of the second and third divisions; division of the sensory root; removal of Meckel's ganglion; ligation of the common carotid artery; neurectomy of termi-

nal branches of the fifth nerve; division of motor nerves; injections of osmic acid (page 779); injections of alcohol; massive doses of strychnin (Dana) and purgatives (Esmarch). The distribution of the fifth nerve, the seat of pain in tic douloureux, is shown in Fig. 423.

Treatment of Neuralgia of Stumps.—Excise the scar; find the bulbous end of the nerve and cut it off. Senn tells us to section the nerve by V-shaped cuts, the apex of the V being toward the body, and to suture the flaps together. Senn's method will prevent recurrence. In some cases reamputation is performed. In entanglement of a nerve in a scar remove a portion of the nerve above the scar and also the neuroma in the scar.

# Wounds and Injuries of Nerves.

Section of Nerves (as from an incised wound).—After nerve-section sensation and motor power are lost at once. The entire peripheral portion of the nerve degenerates and ceases structurally to be a nerve in a few weeks, but after many months, or even years, the nerve may regenerate. The proximal end degenerates only in the portion immediately adjacent to the section;

it rapidly regenerates, and if it does not adhere to the peripheral segment a bulb or enlargement composed of fibrous tissue and small nerve-fibers forms just above the line of section; this bulb adheres to the perineural tissues. The entire distal end degenerates, but new axis-cylinders form in this segment by proliferation of the nuclei on the sheath of Schwann. Union of a divided nerve is brought about by the projection of axis-cylinders from the proximal end or from each end and the fusion of these cylinders. The nearer the two ends are to each other, the better the chance of union. When a nerve has been divided and has not been sutured, abolition of function may be permanent or restoration may occur. Sensation may return in from six weeks to several months. Motor power may never return. If it does return it will do so long after sensory restoration. Restoration of motor power requires from twelve weeks to three and one-half years. It is seldom noted before six months. The return is always slow (John B. Murphy, in "Surg. Gynec., and Obstet.," April, 1907). Failure of return means that the ends are separated by a wide interval or that fascia is interfused between them. In some recorded cases motion and sensation have returned with great rapidity, due, some have said, to anastomoses with adjacent nerves. Murphy shows that when restoration begins, trophic energy returns even before sensation, and when trophic energy returns the blueness and coldness of the limb lessen.

The nerve-fibers which convey impressions of cutaneous pain and of extreme heat and cold-regenerate far more rapidly than those which subserve sensations of light touch and slight degrees of heat and cold.

The investigations of Head and others show that restoration does not begin at the normal area and spread from there over the anesthetic area, but that the reverse is the case. It begins from the confines of the anesthetic area and spreads toward the normal part.

General Symptoms.—Immediately after nerve-section vasomotor paralysis comes on, and for a few days the paralyzed part presents a temperature higher than normal. It then becomes blue and cold. Pronounced changes occur in the trajectory of a divided nerve. The muscles degenerate, atrophy, and shorten, and develop the reactions of degeneration. When union of the nerve occurs, the muscles are restored to a normal condition. If the nerve contains sensory fibers, complete anesthesia (to touch, pain, and temperature) usually follows its division; but if a part is supplied by another nerve as well as by the divided one, anesthesia will not be complete. Trophic changes arise in the paralyzed parts. Among these changes are muscular atrophy; glossy skin; cutaneous eruptions; ulcers; dry gangrene; painless felons; falling of the hair; brittleness, furrowing, or casting off of the nails; joint-inflammations; and ankylosis. The diagnosis as to which nerve is cut depends upon a study of the distribution of motor and sensory paralysis.\*

A curious fact that was pointed out by Letiévant is that after division of a nerve blunt pressure may be appreciated over the entire analgesic area. This phenomena was long thought to be due to nerve anastomoses, the sensory areas from different nerves overlapping. The explanation now given is founded on Sherrington's demonstration that the motor branches of a mixed nerve carry sensory fibers through muscles and tendons, and Head's proof that certain afferent fibers convey impressions of deep sensibility as produced by pressure-

<sup>\*</sup>See Bowlby on "Injuries of Nerves."

The Symptoms of Division of Nerves.—Brachial Plexus.—If one or more cords of the brachial plexus are divided, motor paralysis and anesthesia appear in the limb, the extent of the paralysis and the area of the anesthesia depending upon the cord or cords involved. It should be remembered that the inner cord of the brachial plexus gives origin to the ulnar nerve; the inner and outer cords give branches which fuse to form the median nerve. The posterior cord gives origin to the subscapular, the circumflex, and the musculospiral nerves. The outer cord gives origin to the external anterior thoracic and the musculo-cutaneous, as well as to the outer trunk of origin of the median.

Evulsion of the brachial plexus is sometimes effected by an injury, when the arm is not lost. Algernon T. Bristow ("Annals of Surgery," Sept., 1902) reports 3 cases of this rare injury, and has collected 24 undoubted instances. One of his own cases was operated upon the third day after the accident. In this case there was complete paralysis of the upper extremity, with the exception of the sensory area of the intercostohumeral and the circumflex nerves. The accident had been inflicted by the patient's forearm becoming entangled in a rope, which was pulled upon by a steam winch. On reaching the hospital he felt severe pain, referred to the arm. There was much swelling in the inner portion of the subclavian triangle, the left pupil was contracted, and it seemed likely that the nerves had been evulsed close to the intervertebral foramina. From the fact that sensation was preserved in the skin of the convexity of the shoulder down to the insertion of the deltoid, Bristow concluded that some fibers of the posterior cord of the plexus had escaped division; but when the operation was performed, this conclusion was found to be erroneous. An incision was made, and it was found that the plexus had given way at the point where the four cervical nerves and the last dorsal unite to form the three trunks. In order to reach the lower ends, it was necessary to saw the clavicle and divide the two pectoral muscles; and the torn ends of the nerve-trunks were found underneath the clavicle. Suturing was performed. The ends of the sawn clavicle were sutured together, the wound was closed and dressed, and the arm was put up in Sayre's dressing.

This article of Bristow's is of extreme interest. He discusses the injury to the sympathetic and the reason that sensation was preserved over the area usually supplied by the circumflex. After the performance of this operation sensation over the entire upper arm returned. We agree with Bristow that after such an injury early operation is the only thing that offers any prospect of the return of function. It may be necessary to perform nerve anastomosis, uniting the end of the distal segment of a divided trunk with an undivided trunk. I myself once operated upon a patient that had developed paralysis, motor and sensory, after violent stretching of the arm. In the light of Bristow's case I assumed that evulsion of the plexus had probably taken place. Incision disclosed the fact that the plexus was intact, but was surrounded with dense scar-tissue. This tissue was removed, so as to loosen the nerves; but I have lost track of the patient, and do not know the result. My patient was operated upon many months after the injury. It is well to bear in mind that in an injury of the supraclavicular division of the brachial plexus there will probably be palsy of the great serratus muscle.

Murphy points out that an injury above the clavicle will involve the cir-

cumilex and musculospiral—that as the great pectoral is supplied from both the external and internal cords of the plexus, complete paralysis of the great pectoral proves that both cords are involved and that unimpaired movements of the diaphragm on the side of the lesion (observed with the fluoroscope) show that the cords of the plexus are not divided within the foramina, but well outside of them (John B. Murphy, in "Surg., Gynec., and Obstet.," April, 1907).

Brachial Birth Palsy.—It has been pointed out by Clark, Taylor, and Prout ("Am. Jour. Med. Sciences," Oct., 1905) that brachial birth palsy results from tension on the nerve-trunks by overstretching during delivery, the nervesheath first rupturing and then the nerve-fibers. When the sheath ruptures hemorrhage occurs, fibrous tissue forms, and the scar presses on the intact, slightly stretched, or actually lacerated nerve and prevents repair. The authors tell us that the fifth cervical root first gives way, then the sixth, and so on down the plexus if there is sufficient force. In the mild cases the fifth root alone suffers. They call it brachial birth palsy, or laceration palsy, and sum up the symptoms in a severe case as follows: The arm hangs powerless; abduction at the shoulder is impossible because of deltoid and supraspinatus palsy; the forearm is extended and flexion is impossible because of biceps, brachialis anticus, and supinator longus palsy; palsy of supinator brevis and biceps causes pronation of hand; there is inward rotation of the humerus because of palsy of the supraspinatus, infraspinatus, and teres minor.

Brachial birth palsy is manifest soon after its infliction by evidences of pain on handling the extremity, the pain being due to neuritis (authors above quoted). Medical treatment is relied on for one year, and then, if improvement is not manifest, operation is indicated (page 786).

Posterior (Long) Thoracic Nerve.—Division of this nerve causes paralysis of the serratus magnus muscle, which is made evident by eversion from the thorax and rotation of the scapula when the arm is taken forward (wing-like scapula). In paralysis of this muscle the arm cannot be raised above the horizontal.

Suprascapular Nerve.—Division of this nerve produces some anesthesia over the scapula and paralysis of the supraspinatus and the infraspinatus muscles. The supraspinatus is but an adjuvant to the deltoid and palsy of it is not manifestly disabling. Palsy of the infraspinatus renders external rotation of the humerus impossible, and writing becomes most difficult because the pen cannot be moved along the paper. Sewing, too, is greatly interfered with.

Circumflex Nerve.—Division of the circumflex nerve produces paralysis of the deltoid muscle, so that it becomes impossible to lift the arm to a right angle with the body. There is some slight retention of power in the anterior fibers, which are supplied by the anterior thoracic nerve. The skin over the lower part of the muscle is usually anesthetic.

Musculoculaneous Nerve.—Division of this nerve produces paralysis of the biceps and of the brachialis anticus muscles (paralysis of the forearm flexors). This palsy becomes especially evident when the forearm is supinated, because in this position the supinator longus can no longer act as a flexor of the elbow. There is anesthesia of the radial side of the forearm anteriorly and posteriorly.

The Musculos piral or Radial Nerve.—Division of this nerve high up near the plexus causes paralysis of the extensor muscles of the elbow and the wrist, of the supinators, and of the long extensors of the thumb and fingers. When divided near the middle of the humerus, the triceps usually, but not invariably, escapes. If the injury is below the branch going to the supinator longus, that muscle will escape; otherwise it will become paralyzed. The extensor palsy causes wrist-drop and loss of the power of extending the first phalanges of the fingers and thumb; and, as Gowers has pointed out, flexion is reduced to one-third of the normal, the flexors having lost power "from the loss of antergic support." As a rule, in musculospiral palsy there is loss of supination. Sensibility is sometimes greatly affected, and sometimes very slightly. If the injury is above the level of the musculospiral groove there will be anesthesia in the area supplied by the sensory fibers of the nerve



Fig. 424.—Paralysis of musculospiral nerve after fracture of the humerus ("wrist-drop"); but when fingers have been flexed into palm, a, they can be extended, b, at first interphalangeal joints by lumbricals and interossef, which are supplied by the ulnar and median nerves (Erichsen).



Fig. 425,—Distribution of sensory nerves on the backs of the fugers: r, Musculospiral or radial nerve; u, ulnar nerve; m, median nerve (Krause).

(Fig. 429). If the nerve is injured in the musculospiral groove there are seldom sensory disturbances. Anesthesia rarely occurs in the upper arm in any case, and even after an injury in the groove the hand sensation may be normal or nearly so. Fig. 424 shows the position of the parts in musculospiral palsy and Figs. 425 and 420 the sensory distribution of the nerve.

The Median Nerve.—After division of the median nerve there is paralysis of the pronators; the flexor carpi radialis; the finger flexors, except the ulnar portion of the deep flexor; the abductors, and the flexors of the thumb; and the two radial lumbricales. The forearm can be placed in a position midway between pronation and supination; but further pronation cannot be voluntarily effected. In executing flexion of the wrist a strong deviation toward the ulnar side takes place. The thumb is in a position of extension and abduction, and cannot be brought into apposition with the finger-tips. The second phalanges of the fingers cannot be flexed on the first, and the distal phalanges of the first and second fingers cannot be voluntarily flexed. The corresponding phalanges of the third and fourth fingers can be flexed, this being accomplished by the unparalyzed ulnar half of the deep flexor. Flexion of the first phalanges is still possible, as it is accomplished by means of the interossei. The

extensor action of the interossei muscle upon the middle and distal phalanges, being unopposed, may eventually cause subluxation. The sensory distribution of the median nerve is shown in Figs. 425, 426, 427, and 429. It is the sensory nerve of the radial side of the palm, the front of the thumb, the first and second fingers and half of the third finger, and the back of the last



Fig. 426.—Section of median nerve; areas of anesthesia (heavy shading) and of dysesthesia (light shading) on palmar surface of band (Bowlby).



Fig. 427.—Section of median nerve; regions of anesthesia and dysesthesia on dorsal surface of hand (Bowlby).

phalanx of the index and the middle finger (Gowers). The sensory changes after median paralysis are quite variable—sometimes wide-spread and complete, at other times trivial, and occasionally absent. Gowers says that if there is anesthesia it is usually of the palmar surface, and may also occur on the dorsal aspect of the ends of the first two fingers.



Fig. 428.-Division of ulnar nerve.

The Ulnar Nerve.—When the ulnar nerve is divided, there is paralysis of the flexor carpi ulnaris, of the ulnar portion of the deep flexor, of the muscles of the little finger, of the abductor pollicis, and of the inner end of the flexor brevis pollicis (Gowers). It becomes impossible to adduct the thumb, and the majority of the movements of the little finger are abolished. Flexion of the fingers is impossible at the first joints, and extension is impossible at the other joints; but, as Gowers points out, the loss is slighter in the first fingers than in the others, because the lumbricales of the first two fingers supplied by the median nerve. Interosseal flexion is impossible, and opponents of the interossei, acting without normal antagonism, contract and personal supplies the interossei.

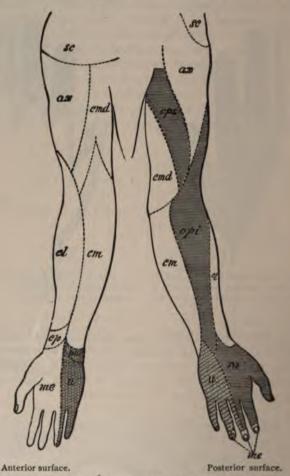
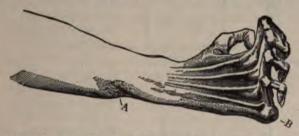


Fig. 429.—Distribution of the cutaneous nerves to the shoulder, arm, and hand. The region of the N. radialis is represented by the unbroken hatched line, that of the N. ulnaris by the broken hatched lines. a, Anterior, b, posterior surface; sc, Nn. suprascapular (plexus cervicalis); ax, chief branch of N. axillar.; cps, cpi, Nn. cutanei post, sup, and inf. (from N. radialis); ra, terminal branches of N. radialis; cm, cl, Nn. cutanei medius (also to the plexus) and lateralis (chiefly to the N. medianus); cp, N. cutan. palmar., N. rad.; cmd, N. cutan. medialis; me, N. medianus; u, N. ulnaris; epu, N. cutan. palm. ulnaris (Henle).

duce what is known as claw-hand (Figs. 428 and 430), a condition in which the first phalanges are overextended and the others are flexed. The sensory loss in ulnar paralysis is extremely variable. The sensory distribution is to the ulnar side of the hand, both back and front, involving the little finger, the ring-finger, and the ulnar half of the middle finger (Figs. 425, 429, and 431).

Lumbar Plexus.—The lumbar plexus supplies the cutaneous surface of the ower portion of the abdomen, of the front and the sides of the thigh, and of he inner portion of the leg and foot (Fig. 432). It innervates the flexors and idductors of the hip-joint, the extensors of the knee, and the cremaster nuscle. The branches sent to the leg are the obturator and the anterior nural nerves.

Sacral Plexus.—The sacral plexus supplies the extensors and rotators of he hip, the knee-flexors, and all the muscles of the foot; also the skin of the luteal region, the back of the thigh, the outer portion and the posterior part



4.30.—Paralysis of ulnar nerve from wound at A; contracture of common extensor with posterior luxation of first phalanges; B, head of metacarpal bone (Duchenne).

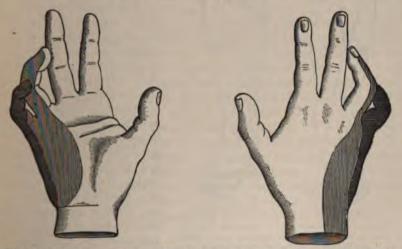


Fig. 431.-Showing sensory loss and ordinary position in injuries of the ulnar nerve (Bowlby),

of the lower leg, and most of the foot (Gowers) (Fig. 432). Its chief branches are those to the external rotators of the hip—the gluteal nerve, the small sciatic, and the great sciatic.

The Anterior Crural Nerve.—When this nerve is divided, the extensor muscles of the knee are paralyzed. The psoas muscle is not affected, even if the nerve is divided within the abdomen; but high division may produce paralysis of the iliacus muscle. In anterior crural palsy the skin is anesthetic over almost the entire thigh, the inner surface of the leg and foot, and the inner sides of the first and second toes (Fig. 432).

The Obturator Nerve. - In obturator palsy the adductor muscles of the thigh are paralyzed, and, in consequence, the patient is unable to cross one points out that external rota-

tion of the thigh is also interfered with.

The Superior Gluteal Nerve. -The division of this nerve paralyzes the gluteus medius and the gluteus minimus muscles, and there is "loss of abduction and circumduction of the thigh" (Gowers).

The Small Sciatic Nerve. -Division of this nerve para lyzes the gluteus maximus mus cle and produces anesthesi of the upper half of the calf the leg and of the middle thi of the back of the thigh (Gowe

The Great Sciatic Nerve (Fig. 432). If this nerve is divided the sciatic notch, there paralysis of the flexor These cles of the leg. cles, as Gowers points ou also extensors of the hip. is likewise paralysis of a muscles below the knee however, the injury is bel upper third of the thigh is no paralysis of the fle the leg. If the nerve is d on a level below the sr atic, there is anesthesi outer portion of the le sole of the foot, and o the dorsum of the

432). External The Nerve.-When this damaged, there is the tibialis anticus extensor longus dig extensor brevis dig

the peronei; and the patient is unable to flex the ankle and first phalanges of the toes. When he tries to walk, he canno from the ground; and eventually there is the development of ta

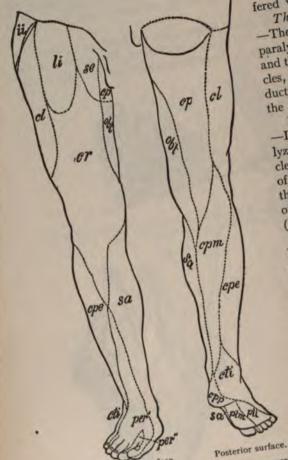


Fig. 432,-Distribution of the cutaneous nerves of the lower extremity: ii, N. ilio-inguinal. (plex. lumb.); li, N. lumbo-inguinal. (to the genitocrural, plex. lumbal.); se, N. spermat. ext. (to the genitocrural); ch. N. cutan. post. (plex. ischiad.); cl, N. cutan. lateral. (plex. lumb.); cr, N. cruralis (plex. lumbal.); obt, N. obturator. (plex, lumb.); sa, N, saphen. (plex, lumbal.); cpe, N. commun. peron. (N. peron. tibial.); cti, N. commun. tibial; per, per', N. peronæi ram. superfic. et prof.; cpm, N. cutan. post. med. (plex. ischiad.); cpp, N. cut. plant. propr. (N. tib.); plm,

pl, N. plantar, medial, et lateral. (N, tib.) (Henle).

(Gowers). The anesthesia is manifest on the outer portion of the anterior surface of the leg, and also on the dorsum of the foot (Fig. 432).

The Internal Popliteal Nerve.—Damage to this nerve paralyzes the posterior tibial muscle, the flexor longus digitorum, the muscle of the calf, the popliteus muscle, and the muscles of the plantar surface of the foot. The toes become flexed at the two distal joints, and extended at the proximal joints. Walking is greatly interfered with. There is loss of the power of rotating the flexed leg inward, if the damage is above the branch to the popliteus muscle; and extension of the ankle-joint is lost. As the consequence, talipes calcaneus develops (Gowers). The anesthesia is variable, but usually involves the sole of the foot and the outer surface and lower portion of the back of the leg (Fig. 432).

The Plantar Nerves.—Division of the internal plantar nerve paralyzes the short-toe flexor, the two inner lumbricales, and the plantar muscles of the great toe, except the adductor (Gowers). There is anesthesia of the inner portion of the sole of the foot and of the plantar surface of the three inner toes and of half of the fourth toe (Fig. 432).

Division of the external plantar nerve causes paralysis of the muscles of the little toe, of the adductor of the great toe, of all the interosei, of the two outer lumbricales, and of the flexor accessorius (Gowers). There is anesthesia of the skin of the outer half of the sole of the foot, of the little toe, and of half of the fourth toe (Fig. 432).

The Facial Nerve.—The nerve may be divided during the mastoid operation or may be lacerated by a fracture of the petrous portion of the temporal bone and a peripheral palsy results. The face is asymmetrical and is drawn to the sound side. Asymmetry becomes more marked on attempting to smile or to show the teeth. Whistling and frowning are impossible. Sense of taste may be less acute or lost on the anterior two-thirds of the tongue. There is relaxation of the palate and deviation of the uvula. Reactions of degeneration can be demonstrated in the palsied muscles. In some cases there are sensory disturbances (hyperesthesia or anesthesia) and in some there are vasomotor perturbations on the palsied side. On the paralyzed side the muscles are relaxed, the nasolabial fold is to a great extent gone, the nostril cannot be dilated. The brow wrinkles have been smoothed out, the eyelids cannot be closed; on attempting to close the eye the globe tilts upward and outward, the cornea and conjunctiva inflame, the lower lid droops, and tears run down the cheek.

Treatment.—In all recent cases of nerve-section, try, if possible, to suture the ends of the divided nerve. Primary suture means suture within twenty-four hours of the accident. In 123 reported cases of primary suture, 119 were cured in from one day to one year (Willard). The return of sensation may be rapid or may be slow; muscular power returns more slowly than sensation. If the patient is not seen until long after the accident, incise and apply utures (secondary sutures); if the nerve cannot be found, extend the incision, and the trunk above and trace it down, and find the trunk below and follow up. In 130 reported cases of secondary suture 80 per cent. were more or less proved (Willard). Even after primary suture, loss of function is bound to tur for a time. After secondary suture, sensation may return in a few s, but it may not return until after a much longer period; in any case

muscular function is not restored for months. After partial section of a nerve the ends should be sutured. In performing secondary suture it may be necessary to effect "lengthening" in order to approximate the ends. Transplantation of a portion of nerve is sometimes practised (implantation or anastomosis). Nerve-grafting is bridging the gap by means of a portion of nerve from one of the lower animals or from a recently amputated human limb. Nerve-transplantation may fail utterly; it may be followed by great improvement, but absolute and perfect restoration of function cannot be obtained. R. Peterson \* has made a study of the 20 recorded cases of nervegrafting; 8 of the operations were primary and 12 were secondary. The periods after the injury at which operation was performed varied from fortyeight hours to a year and a quarter; 4 of the 8 primary cases improved; 8 of the 12 cases of secondary operation showed improvement in motion or sensation. The distance between the nerves did not seem to affect the results. No case recovered completely, but in one case sensation returned completely and only the abductors of the thumb remained weak. In most of the cases that were benefited sensation returned by the tenth day and motion within two and a half months. In one of the successful cases, that of A. W. Mayo Robson,† the spinal cord of a rabbit was used. A facial nerve divided in the aqueduct of Fallopius may perhaps be sutured at the site of the injury. This should be attempted as soon as the palsy is observed, as was suggested, I believe, by Frederick Sydenham ("Brit. Med. Jour.," May 8, 1909). If the ends of the divided nerve cannot be approximated, suture à distance may be practised, as was done successfully by Sydenham (Ibid.). If suture at the site of injury is impossible the end of the peripheral segment of the divided nerve may be anastomosed to the hypoglossal, glossopharyngeal, or spinal accessory nerve (page 776).

Pressure upon nerves may arise from callus, scars, a dislocated bone, a tumor, or an external body.

The symptoms may be anesthetic, paralytic, or trophic.

The treatment is as follows: Remove the cause (reduce a dislocated bone, chisel away callus, excise a scar, etc.); then employ massage, douches, exer-

cise, and electricity.

Dislocation of the Ulnar Nerve at the Elbow.—This condition is very rare. It may occur as a complication of a fracture or a dislocation, or as an uncomplicated condition. It may be produced by violence or by muscular effort, which ruptures the fascia, the function of which is to retain the nerve back of the inner condyle of the humerus. In some cases the symptoms are slight and transitory, the nerve functionating well in its new situation. As a rule, there are pain, numbness, or anesthesia of the ulnar trajectory, some stiffness of the elbow, and stiffness of the little finger and ring-finger. The nerve can be felt in front of the inner condyle of the humerus. In some cases neuritis follows, with trophic changes.

Treatment.—Expose the nerve by an incision, incise the fibrous tissue back of the inner condyle, and press the nerve into the bed prepared for it and hold it in place by sutures of kangaroo-tendon passing through the triceps

<sup>\*</sup> Amer. Jour. of Med. Sciences, April, 1899."

tendon. Wharton advises suturing also "the margin of the fascial expan-

sion of the triceps tendon superficial to the nerve."\*

Contusion of Nerves.—The symptoms of contusion of nerves may be identical with those of section. Sensation or motion, or both, may be lost. The case may recover in a short time, or the nerve may degenerate as after section.

The treatment at first is rest, and later electricity, massage, frictions, and douches.

Punctured Wounds of Nerves.—The symptoms of punctured wounds of nerves may be partly irritative (hyperesthesia, acute pain, and muscular spasm) and partly paralytic (anesthesia, muscular wasting, and paralysis).

The treatment after the puncture has healed is the same as that for con-

#### OPERATIONS UPON NERVES.

Neurorrhaphy, or Nerve-suture.—When a nerve is completely or partially divided by accident, it should be sutured at the first possible moment. The instruments required are an Esmarch apparatus, a scalpel, blunt hooks, dissecting forceps, hemostatic forceps, curved round intestinal needles or sewing needles, a needle-holder, and fine catgut, silk, or kangaroo-tendon. In primary suture render the part bloodless and aseptic. Enlarge the incision if necessary. If the ends can readily be approximated, pass two or three sutures through both the nerve and its sheath and tie them (Figs. 433 and 434). If the ends cannot be approximated, stretch each end and then suture. The sutures do not traverse the nerve, but go through the perineum and adjacent connective tissue. Remove the Esmarch band, arrest bleeding, suture the wound, dress antiseptically, and put the part in a relaxed position on a splint. After union of the wound remove the splint and use massage, friction, electricity, and the douche. The operation in some instances fails, but in many cases succeeds. In some few cases sensation returns in a few days, but in most cases does not return for many weeks or months. Sensation is restored before motor power. After successful suturing of a divided median nerve sensations of skin pain and of extreme heat and cold appeared in fifty-six days and were restored in twohundred and seven days. Sensations of light touch and slight degrees of heat and cold appeared in two hundred and sixty days and were not completely testored for one year (Kenneth A. J. Mackenzie, in "Annals of Surg.," July, 1909). Secondary suture is performed upon cases long after division of a nerve. If operation is not done for three years or more after division it is very improbable that complete regeneration will ever occur, and yet it is always worth trying, for muscular control has been regained after suturing in one case twenty-nine years subsequent to nerve division (Alfred S. Taylor, in "Jour. of Orthopedic Surg.," Nov., 1908). The part is rendered aseptic and bloodless; an incision is made; the bulbous proximal end is easily found and loosened from its adhesions; the shrunken distal end is sought for and loosened (it may be necessary to expose the nerve below the wound and

<sup>\*</sup>A report of 14 cases of dislocation of the ulnar nerve at the elbow, by H. R. Wharton, Amer. Jour. of Med. Sciences, Oct., 1895.

trace its trank upward); the entire bulb of the proximal end is cut off, along one-quarter of an inch of the distal end is removed. All scar-tissue between the ends is most carefully removed. If the gap between the ends is not wide, each end is gently stretched, and the ends are approximated and sourced together. If stretching does not permit of approximation, adopt the expedient shown in Fig. 334, d, or in Fig. 435. This operation is manufactly the flap method. Another method is to make a bridge of strands of careful running from one divided end to the other. We speak of this plan as nature

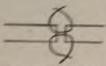


Fig. 433 - Nerre-sottor.

it distance (Fig. 434. e). The categot bridge support the growing reparative material. Guelliot suggested tubulization, that is, erecting barriers along the path of reparative material to keep surrounding tissues from entering and blocking it. Implementation or amazimuse is advisable in some cases. Letiévant attaches the cut end of the peripheral portion of the divided nerve to an

adjacent uncut nerve, which has been partially divided to receive it. Allisuggested shortening the limb by resecting a piece of bone and then suburing the ends of the nerves together. The operation has been carried out successfully by Keen, Rose, and others.

After uniting the ends of the nerve it is highly desirable to protect them from invasion by the scar in the perineural structures. Numerous plans have been employed to obtain such protection. Vanlan surrounded the ends with decalcified bone and Payr with a tube of absorbable magnesium. Gelatin tubes have been used, silver-foil has been tried, and Cargile membrane has

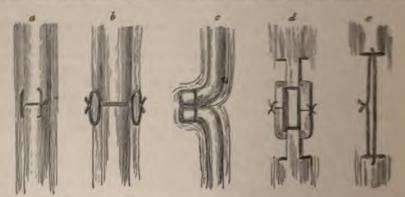


Fig. 434.—Nerve-suture: a, Direct; b, perineurotic; c, paraneurotic; d, e, neuroplasty (Senn).

been employed. None of these plans is satisfactory. Murphy's plan gives the best results. He covers the line of nerve suture with fascia, muscle, or fat. In regions where he cannot obtain suitable covering tissue he wraps about the suture line with a material composed of equal parts of paraffin and oil of sesame. This mixture can be flattened out very thin ("Surg., Gynec., and Obstet.," April, 1907). The peripheral portion of a divided nerve may be inserted into a longitudinal slit of a sound nerve. The anastomosis may be end to side.

The operation is employed after exsection, leaving a very large gap, for facial palsy, for infantile palsy, for evulsion of the brachial plexus, and for brachial birth palsy. Nerve-grafting is practised by some. A. W. Mayo Robson used the spinal cord of a rabbit to fill a gap between the ends of the divided median nerve of a man. The restoration of function was almost complete. Some surgeons have grafted in bits of nerve obtained from a recently amputated limb. It makes no difference whether the grafted nerve was motor or sensory or mixed. The results of grafting are seldom good. Chas. A. Powers ("Transactions of the American Surgical Assoc.," 1904) collected 22 cases from literature, 20 from Peterson's paper, 1 case of Durante's, and 1 of his own. In this series there were 3 good results and 3 "fair" results. The bit of nerve grafted does not participate in repair—it is a mere bridge, and acts as does the stuture à distance.

Neurectasy, Neurotomy, and Neurectomy.—Neurectasy, or nervestretching, may be applied to motor, sensory, or mixed nerves. A nerve can be stretched about one-twentieth of its length. Neurectasy has been employed for neuralgia, neuritis, muscular spasm, hyperesthesia, anesthesia, painful ulcer, perforating ulcer, the pains of locomotor ataxia, and many other onditions. The operation, which was once the fashion, seems to benefit some ases, but it is not now thought so highly of as formerly. The incision for neurotasy is identical with the incision for neurectomy or neurotomy of the same nerve. Neurotomy, or section of a nerve, is performed only upon small and purely sensory nerves. It is performed chiefly for peripheral neuralgia or for the other painful malady. It is useless, because sensation, as a rule, soon returns. Paget saw complete return of sensation in four weeks after division

of the median nerve. Corning endeavers to prevent this regeneration by inserting oil between the ends. He uses oil of theobroma containing enough paraffin to make the melting-point 105° F. The oil is melted, is injected around the nerve, and cold is applied. The nerve is now sectioned with a canaliculated knife, the ends are separated widely, more oil is injected, and cold is again applied. The theory is that this oil, which is solid at the temperature of the body,

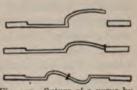


Fig. 435.—Suture of a nerve by splitting the ends (Beach).

devitalizes the nerve at the point of section and acts as a barrier to the passage of regenerating fibers. This method has been applied especially in cervicobrachial neuralgia.\* Neurectomy, or excision of a portion of a nerve-trunk, is applicable only to sensory nerves and to painful affections.

Sympathectomy.—Jonnesco's Operation.—It has long been known that division of the sympathetic nerve in the neck may produce important changes in the eye and in the cerebral circulation. In 1893 Jaboulay divided the sympathetic on each side, for the purpose of treating epilepsy. The removal of the ganglia of the sympathetic was proposed by Baracz; and the operation was first performed by Jonnesco, in 1896, for epilepsy. The operation is performed by some surgeons for epilepsy, for exophthalmic goiter, and for glaucoma and for trifacial neuralgia. In operating for glaucoma the superior cervical ganglion on each side is removed, as it is from this that the sympathetic fibers that pass to the eye are derived. If the operation is done at all, it should be a bilateral one.

<sup>\*</sup> Medical Record, Dec. 5, 1896.

The operation is used in epilepsy on the theory that there is an anemic condition of the brain in this disease which is corrected by producing a hyperemia, and that the hyperemia improves cerebral nutrition. The operation in epilepsy is largely theoretical, although Jonnesco claims 12 per cent of cures in a large number of operations. In exophthalmic goiter there seems to be some distinct evidence that the operation may be beneficial, but Curtis shows that the mortality is high. Personally, I have not employed it in epilepsy, and at the present time I should not be inclined to do so. In exophthalmic goiter, if any operation is necessary, I should perform partial thyroidectomy; but in progressive glaucoma, which is always so absolutely hopeless, the operation is a justifiable procedure and occasionally seems to have a distinct influence in retarding the development of the disease.

The incision should be made along the posterior margin of the sternocleidomastoid muscle. I have become convinced, in performing two operations of this kind and through studies made upon the dead body, that the ganglion may be more easily reached from behind the sternocleidomastoid than from in front of it. The internal jugular vein and the carotid artery are lifted upward and forward; and the superior ganglion will usually adhere to the under portion of the carotid sheath, and be lifted up with it. Theoretically, it is not necessary to open the carotid sheath in this operation, but, practically, this had better be done, so that one may, without any possibility of doubt, distinguish between the pneumogastric and the sympathetic nerve. The moment the nerve is cut, the pupil on that side will contract.

Stretching of the Sciatic Nerve.—Some surgeons stretch the sciatic nerve by anesthetizing the patient and holding the leg and thigh in line, strong flexion being made upon the hip, the entire lower extremity being used as a lever (Keen). This method, which has caused death, inflicts needless damage, and stretching after an incision has been made is safer and better. The instruments required are a scalpel, hemostatic forceps, dissecting forceps, a dissector, retractors, and a scale with a handle and a hook. The patient lies prone, the thigh and legs being extended. An incision four inches in length is made a little external to the middle of the thigh, and going at once through the deep fascia; the biceps muscle is found and is drawn outward; the nerve is discovered between the retracted biceps on the outside and the semitendinosus on the inside, resting upon the adductor magnus muscle. The nerve, which is caught up by the finger, is first pulled down from the spine and then up from the periphery, and finally the hook of the scale is inserted beneath the trunk and the nerve is stretched to the extent of forty pounds. Very rarely is even a single ligature needed. The wound is sutured and dressed. If the incision is made at a higher level below the gluteofemoral crease, the sciatic nerve will be found just by the outer border of the biceps.

Neurectomy of the Infra-orbital Nerve.—This operation was first performed by Abernethy in 1793. The instruments required in this operation are a scalpel, dissecting forceps, aneurysm needle, hemostatic forceps, blunt hooks, a dissector, and metal retractors. The patient lies upon his back, the head being a little raised by pillows. The surgeon stands to the outside of and faces the patient. A curved incision one and a half inches long is made below the lower border of the orbit. The nerve lies in a line dropped from the supra-orbital notch to between the two lower bicuspid

teeth. The nerve is found upon the levator labii superioris muscle. A piece of silk is passed under the nerve by an aneurysm needle and firmly fastened. The upper border of the incision is drawn upward; the periosteum of the floor of the orbit is elevated and held by a retractor; the roof of the infra-orbital canal is broken through; the nerve is picked up far back with the blunt hook and is divided with scissors, and the entire nerve is drawn out by making traction upon the silk. The bleeding in the orbit is checked by pressure. The wound is stitched without drainage.

Neurectomy of the Supra-orbital Nerve.—Before sterilizing the parts shave off the eyebrow. The instruments required and the position of the patient are as for the operation upon the infra-orbital nerve. A curved incision one inch long discloses the nerve as it emerges from the supra-orbital notch or foramen at the junction of the inner and middle thirds of the eye-

brow. The nerve is pulled forward and cut off above and below.

Neurectomy of the Inferior Dental Nerve.—The instruments are the same as for any other neurectomy, and in addition a chisel, a mallet, and a rongeur forceps. Make a curved incision around the angle of the jaw. Lift the supramaxillary branch of the facial nerve downward (Kocher). Separate the masseter muscle with a periosteum-elevator and slight touches with the knife. Chisel an opening in the center of the ascending ramus (Velpeau's rule). This opening exposes the beginning of the dental canal. If necessary, the opening may be enlarged with a rongeur. Pull the nerve

out with a hook and remove a piece from it.

Extracranial Operation for Neuralgia of the Fifth Nerve.—
The operation for removal of the Gasserian ganglion is difficult, bloody, and dangerous. Removal of portions of the pain-haunted nerve-trunks sometimes cures the condition and often ameliorates it for a considerable time. The injection of osmic acid into the peripheral nerves may actually cure or secure prolonged relief. The serious operation of removing the ganglion may be performed if peripheral operations fail or in violent and intractable cases of long standing in which pain is felt in more than one branch. Removal of nerves by ordinary neurectomy often gives comfort for a few months, but rarely gives prolonged relief. If we seek striking benefit by an extracranial operation,

it must be thoroughly done.

Injection of Osmic Acid.—This method was suggested by Bennett, of London, in 1897. Osmic acid had been used for many years in a sort of haphazard way, being thrown into tissues about the nerves by means of a hypodermatic syringe. Bennett suggested exposure of the nerve and the injection of 5 to 10 minims of a 1 per cent. solution. Acid when so used actually destroys nerve-fibers, and a considerable amount of fibrous tissue forms which intercepts regenerating fibers. It is probable that secondary degenerative changes occur in the nerve-trunks, and it is possible that they occur in the ganglion. Murphy warmly advocates the method. It certainly produces immediate relief by causing immediate anesthesia, but whether such relief is permanent it is as yet too early to say. I have used it in several cases with satisfaction. In one case in which I exposed the ganglion I injected that structure and the result seems to be the same as if I had removed the ganglion. In neuralgia of the fifth nerve the painful nerve or nerves should be exposed, and from 5 to minims of a 2 per cent. solution of osmic acid injected into several

theres puts if the same and also between the armount of the count and therefore the following the same and the graphen. See the graphen following the method; he per count should be seed. It was maked the electricity than comic wint. It gives what sometimes after two or more. The method is not to be said I said left in the fairly division. The permanents of the wine is more in the first division. The permanents of the wine is more in the first division and then the armount pain requirement. Recomplete for its morthly and free treatment pain requirement. It was a said dangerous to plungs an instrument so decay among impossion and there must be danger of wounding them.

fire Remon Lower method, and is employed when the con-



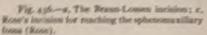




Fig. 427. -Lower jew and regres 100 tools and saw-cuts are shown (820)

ordinary operation, the surgeon requires chisels, fine saws, blunt backs, providinary operation, the surgeon requires chisels, fine saws, blunt backs, provide the surgeon requires chisels, fine saws, blunt backs, provided many operators, silver wire (No. 22), and drills. The infra-orbital series exposed by an incision, a ligature is tied around it, the roof of the morbital canal is opened by a chisel, and the nerve is traced back as far appossible. The wound is then packed temporarily with gauze. The notate the inserted slightly below the external angular process of the frontal bone, is carried back along the zygoma, down in front of the ear to just above the angle of the jaw, and then forward for two inches. This flap, which is composed of skin and subcutaneous fat only, is dissected forward, and Steno's duct and branches of the facial nerve are not damaged. The flap is wrapped in

\* See article by Wm. Rose, "Practitioner," March, 1900.

ed by a transverse incision. At the root of the zygoma two holes are drilled fourth of an inch apart, and two more holes one-fourth of an inch apart are led through the zygomatic process of the malar bone. The zygoma is then ided by a saw (Fig. 437). The posterior saw line runs between the two drilles at the root of the zygoma. The anterior cut passes between the two anior drill-holes. The direction of the first cut is directly downward. The rection of the second cut is downward and forward from above. The arch is red and detached downward and backward. The exposed tendon of the tempal muscle is retracted backward. The removal of a little fat exposes a pterygomaxillary fossa. The internal maxillary artery is exposed, two patures are applied, and the vessel is divided between them. The finger less for the sphenomaxillary and pterygomaxillary fissures. The external crygoid muscle is separated from the greater wing of the sphenoid and from a root of the external pterygoid process. On the edge of the greater wing

the sphenoid a long prominence usually detectable. It overhangs e sphenomaxillary fossa and should cut away by the use of a chisel. he superior maxillary nerve is lifted a blunt hook, is grasped with forps, and is twisted off as near the nglion as possible (Fig. 438). The stal end is drawn upon, and the nerve, ving been previously loosened, is awn back through the infra-orbital nal. The zygomatic arch is wired place, the temporal fascia is sutured th buried sutures, and the skinound is closed. If the pain involved t only the second division, but also e third division, the operation preously described should be performed st, and the third division should be tacked a few weeks later. The third vision is reached by removing the ronoid process. The inferior dental id lingual nerves are found, and are aced up to the foramen ovale, and

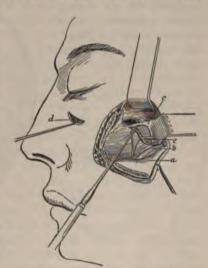


Fig. 438.—a, The zygomatic arch, turned down after sawing; b, tendon of the temporal muscle retracted; c, superior maxillary nerve and Meckel's ganglion; d, infra-orbital nerve emerging from canal; e, internal maxillary artery.

Removal of the Gasserian Ganglion.—This formidable procedure as first suggested by J. Ewing Mears in 1884 and was first performed by Wm. lose in 1890. This operation is often bloody and difficult, and is only indertaken in very severe cases of tic douloureux, in which the first division is wolved, or in cases upon which less grave procedures have failed. Jaboulay and Cavaillin ("Lyon. Med.," May 17, 1908) speak of it as a grave operation if difficult technic which should be left as a final resort. Many operators my that there is a large mortality after gasserectomy and claim that it is only bout 5 per cent. Some operators report a mortality of from 10 to 17 per

cent. The greater the experience of the surgeon in this operation, the smaller will be the mortality. Knowledge of the region and parts, dexterity from frequent repetition, and special training count for much. The operation usually cures the pain if the patient recovers from the actual procedure. It is claimed that the pain may recur even after complete removal of the ganglion. I have never seen this occur and am disposed to think that recurring pain is apt to mean that there was a partial removal. Carson collected 100 cases, Murphy and Neff 42 cases. The mortality in this group of 142 cases was 15 per cent. Most of the cases reported by Murphy and Neff were operated upon during or after 1899, and in this group the mortality was 10 per cent. ("Progressive Medicine," March, 1903). In Lexer's series of 201 cases, referred to below, the mortality was 17 per cent. In many cases a perfect cure is obtained. In some few the pain returns upon the side operated upon. Occasionally it

arises on the side not operated upon. In some cases ulceration of the cornea follows operation. Such ulceration may be trivial, may result in opacity, or may destroy the eye.



Fig. 439.—Hartley's osteoplastic flap in removal of Gasserian ganglion (Tiffany).



Fig. 440.—Removal of Gasserian ganglion; a, Middle meningeal artery; 11, ophthalmic division; 111, submaxillary division; G, ganglion (Krause).

Paralysis of the abducens occurs in some cases. The hemorrhage may be so profuse as to require packing of the wound and suspension of the operation for a few days. The bleeding may come from the meningeal artery, from the sinus, or from the veins of Santorini. Lexer ("Arch. f. klin. Chir.," Bd. lxv, H. 4) gives a table of 201 cases. Of the survivors, 93.4 per cent, were apparently cured. In two-thirds of the cases the trouble was right-sided. In 10 the operation was temporarily abandoned because of hemorrhage. The experience of surgeons in general is that after the removal of the ganglion there is apt to be some atrophy of the tongue and the eye usually becomes insensitive and watery. The masseter muscle will be paralyzed.

The Hartley Operation for Removal of the Gasserian Ganglion .-

This operation was first performed by Hartley in 1891, five months before Knause performed it. The surgeon is provided with the instruments for osteoplastic resection of the skull. Special retractors, various hooks, scalpels, a dry dissector, dissecting and hemostatic forceps, and an electric foreheadlight are required. Long strips of gauze must be ready for packing in case of hemorrhage. The patient is placed recumbent, with head turned to the opposite side. The application of a provisional ligature or clamp to the external carotid artery is advocated by some, but this step will not control the venous bleeding, which is the most harassing hemorrhage encountered. Many operators form a large osteoplastic flap in front of the ear (Fig. 430) and break it out. I do not believe that an osteoplastic flap is necessary. The temporal fascia is so thick and tense that when the wound in it is carefully sutured protection is perfect and safety is secured. Hemorrhage is arrested. It may be found that the meningeal artery has been ruptured. If this accident has happened and the vessel lies in a bony canal, plug with Horsley's wax. If the vessel is bleeding upon the dura, ligate by passing suture-ligatures around it. If it is torn off at the foramen spinosum, pack the foramen with iodoform gauze, and postpone the conclusion of the operation for forty-eight hours. It may be necessary at any stage of this operation to pack the wound and postpone completion for two days. Some surgeons (Krause, Bergmann) ligate the meningeal artery as a routine procedure, but this operation may be difficult and require much time. If the unligated vessel is divided, the hemorrhage can be arrested by gauze packing or by plugging the foramen spinosum with a bit of sterile wood, but it is best to ligate the vessel. The head and body of the patient should now be elevated. This allows the brain to drop posteriorly and renders forcible retraction unnecessary, and, further, it lessens venous bleeding (Lexer). The next step is to lift up the dura and with it the brain (Fig. 440). Find the inferior maxillary nerve and clamp it with hemostatic forceps. Find the superior maxillary nerve and clamp it. Uncover the ganglion. Loosen the nerves from their beds with a dry dissector and divide each one at its foramen of exit. Twist the clamp forceps so as to reel up the nerves. This pulls out the ganglion intact with the motor root and the root of origin, as far back as the pons (Krause's method). Arrest bleeding; close the flap; sew the lids of the affected side together, and cover the eye with a watch-crystal.

Cushing has modified the Hartley operation so as to permit of extradural manipulation below the arch made by the middle meningeal artery and thus lessen the danger of laceration of the artery ("Jour. Amer. Med. Assoc.," April 28, 1900). The anterior arm of the incision of the soft parts is so placed that it does not cut the nerve to the occipitofrontalis muscle. Thus drooping of the lid and oblation of brow wrinkles on that side are avoided. He trephines the wall of the temporal fossa very low down, opens into the skull below the arch of the meningeal vessels, and thus avoids the meningeal at the foramen spinosum of the sphenoid bone and the sulcus arteriosus of the parietal bone.

Horsley's Intradural Method.—An opening is made into the middle lossa of the skull, the dura is opened, and the ganglion is found and removed. This operation is easier than the extradural method, but is believed to be more dangerous.

The Frazier-Spiller Operation of Intracranial Neurotomy of the Sensory Root of the Trigeminus.—If experience shows that after division of the sensory root the nerve does not regenerate, and it seems probable that it does not, the operation must be regarded as a valuable addition to our resources. This operation is by many surgeons preferred to removal of the ganglion. In this operation the zygoma is temporarily resected. The temporal fossa is exposed, the bony wall is trephined, and the trephine opening is enlarged by the use of a rongeur. The dura is separated and the ganglion and its sensory root exposed. The dural envelope of the ganglion is opened, is separated, and the sensory root is exposed. The sensory root is then picked up on a blunt hook and divided. It is frequently possible, Frazier tells us, to separate the sensory root from the motor root. In this operation we avoid the venous hemorrhage from the foramen ovale and foramen rotundum which is apt to be encountered when removing the ganglion.

Abbe's Operation of Intracranial Neurectomy of the Second and Third Divisions.—This operation is preferred by Charles A. Ballance, who opposes exposure of the ganglion or division of the sensory root unless the first division of the nerve is the seat of pain. He advocates this in spite of knowing full well that the pain may return in a few years. He advocates it because of its safety, its simplicity, its freedom from serious hemorrhage, its avoidance of opening the intradural space and of all danger of corneal anesthesia, and also because if pain returns the operation can be repeated. The operation is performed as follows: Ligate the external carotid artery of the diseased side, make a vertical incision over the middle of the zygoma down to the bone. An opening into the skull is made by a mallet and gouge, and this opening is enlarged by a rongeur until it is one and one-half inches in diameter. The dura is lifted from the middle fossa and the nerves are exposed. Each nerve-trunk is clamped, is divided near its foramen of exit, and is separated from the ganglion by cutting or by twisting with the forceps. A strip of sterile rubber tissue, one and one-half inches in length and three-fourths of an inch in width, is laid over the round foramen and the oval foramen and is pressed into place by gauze. In a few moments the gauze is withdrawn and the ganglion is allowed to descend upon the rubber tissue. The wound is then closed. (See Robt. Abbe, in "Annals of Surgery," Jan., 1903.) The rubber tissue is used to block the foramina of exit and prevent future emergence of regenerating nerves. Mayo Robson blocks the foramen with a thin plate of lead or silver, a knob of the plate entering the oval foramen to prevent displacement.

Division of the Auditory Nerve for Tinnitus Aurium.—Balance has performed this operation on the right side with success in a most distressing case of painful tinnitus.

When the cerebellar hemispheres were displaced by marine sponges the nerves of the posterior fossa were brought into view. He divided the eighth nerve, but made no attempt to preserve the nerve of Wrisberg. Five months after operation the patient was well except for deafness and deviation of the tongue to the left. (See Ballance, in "Lancet," 1908, vol. ii.) Frazier has divided the auditory nerve for vertigo.

Operation for Facial Paralysis of Extracerebral Origin (Facioaccessory Anastomosis and Faciohypoglossal Anastomosis).—Operation for this condition was first performed in 1895. (See "Remarks on the

Operative Treatment of Facial Palsy of Peripheral Origin," by Chas. A. Ballance, Hamilton A. Ballance, and Purves Stewart, "Brit. Med. Jour.," May 2, 1903; and also the "Surgical Treatment of Facial Paralysis by Nerve Anastomosis," by Harvey Cushing, "Annals of Surgery," May, 1903.) In 1898 Furet suggested to Faure that he should anastomose the peripheral end of a divided facial nerve to that portion of the spinal accessory nerve which goes to the trapezius muscle. Faure did this, but the operation failed. Robert Kennedy, of Glasgow, did the first successful operation. He divided the facial for the relief of spasm and at once anastomosed a partially divided spinal accessory. The procedure first employed by Ballance was, after noting by galvanism that muscular fiber still remained, to expose the facial nerve at its point of exit from the stylomastoid foramen, to cut the nerve-trunk across as high up as possible, to expose the spinal accessory, and to suture the distal end of the facial into the trunk of the spinal accessory. The spinal accessory was cut half through to make a bed for the end of the facial. The paper of the Ballances and Stewart above referred to recommends end-to-side anastomosis between the divided facial and the hypoglossal. The authors have operated five times for facial palsy. Cushing, Keen, Hackenbruch, Körte, Currie, Beck, Vidal, Girard, Lund, Alt, Frazier, and others have done similar operations. Marked improvement may follow operation even if a palsy has lasted for a considerable time. Improvement followed operation in Currie's case, although the palsy was nearly a year old. The period when improvement should be expected is uncertain. Signs of improvement may not be evident for six months or longer. In Cushing's cases they begun in thirteen days. In Kennedy's case in seven days. In most cases operation restores facial symmetry when at rest and in many cases volitional movements. The patient will often become able to close the eye and raise the angle of the mouth. Curious associated movements may occur. In Currie's case when the patient lifted his shoulder there was contraction of the occipitofrontalis muscle ("South African Med. Record," 1907).

Facio-accessory anastomosis does not restore emotional movements, but faciohypoglossal anastomosis may restore them. Küster reports a case which confirms this.

Operation is indicated when a complete facial palsy is of such duration that tecovery is not to be hoped for by longer delay. The Ballances and Stewart believe that when a palsy has lasted six months without sign of recovery, operation is indicated. A paralysis due to traumatism gives a much better prognosis after operation than does a paralysis due to a septic process (Chas. A. Ballance, Hamilton Ballance, and Purves Stewart, in "Brit. Med. Jour.," May 2, 1903). Murphy has collected 33 cases of anastomosis of the facial nerve with the spinal accessory, hypoglossal, or glossopharyngeal, and Joseph Beck has added 5 cases of his own in which he performed faciohypoglossal anastomosis.

The hypoglossal is preferred to the accessory. Its trunk is larger and its cortical center is adjacent to the facial cortical area. After such an operation associated movements are not observed when the mouth is kept closed and, if Gowers is correct, the fibers of the facial, which supply the muscles closing the mouth, may take origin from the hypoglossal nucleus (John B. Murphy, in "Surge, Gynec., and Obstet.," April, 1907). Murphy points out that an

anastomosis may be end to end, implantation of the facial into a slit in the other nerve, implantation of the facial into a partial transverse division of the other nerve or end to side (Ibid.).

Operation for Brachial Birth Palsy.—(See article by L. P. Clark, A. S. Taylor, and T. P. Prout, in "Am. Jour. Med. Sciences," Oct., 1905.) These authors report 8 cases of operation with some notable improvements and with 2 deaths. In these cases they found great thickening of the fascia and in some cases fibrous tissue almost completely obscured the remains of lacerated trunks or roots. They advise that the patient be placed recumbent, with a sand-pillow beneath the shoulders and with the head extended and bent toward the opposite shoulder. An incision is made at the posterior border of the sternocleidomastoid and the plexus is exposed and explored. If the lesion is above the clavicle, it is at once attacked; if below that bone, the incision is carried down, and the bone is sawed in two. The scar tissue with the lacerated nerves is removed and the nerves or nerve-roots are sutured. The wound is closed, the clavicle being wired if it was divided. After dressings are applied the head is bent toward the shoulder of the damaged side and fixed with plaster-of-Paris.

I operated on a case of Dr. Charles S. Potts's in the Phila. Hospital, The roots were not torn, but were found imbedded in a thin layer of scar which it was possible to remove. The result was good. Nerve anastomosis may be necessary if exsection of scar leaves an unbridgable gap or if nerve roots were divided with foramina.

## XXIII. DISEASES AND INJURIES OF THE HEAD.

DISEASES OF THE HEAD.

In approaching a case of brain disorder, first endeavor to locate the seat of the trouble; next, ascertain the nature of the lesion; and, finally, determine the best plan of treatment, operative or otherwise. In all operations upon the brain the surgeon must be able to determine accurately the situations



Fig. 441.—The meningeal artery exposed by trephining (after Esmarch).

of certain fissures and convolutions, the finding of the situations of these convolutions and fissures comprising the science of craniocerebral topography.

The regional terms used in craniocerebral topography are derived from Broca (Fig. 442). The middle meningeal artery is found at the plerion, one and onequarter inches posterior to the external angular process, on a level with the roof of the orbit (Fig. 441). The fissures and convolutions of the brain are shown in Figs. 443-445). The fissure of Bichat is marked by a line on each side drawn from the inion to the external auditory process.

A line from the glabella to the inion overlies the median fissure and the superior longitudinal sinus. The fissure of Rolando is very important, as marking the pos-

terior limit of the motor region of the brain. It begins near the median line, half an inch posterior to the middle of the distance between the inion and glabella (Thane). This fissure runs downward and forward at an angle of 67.5°



Fig. 442.—Skull, showing the points named by Broca: As, Asterion (junction of the occipital, patietal, and temporal bones); basion, middle of anterior wall of foramen magnum; B, bregma (junction of the sagittal and coronal sutures); G, ophryon (on a level with the superior border of the eyebrows, and corresponding nearly to the glabella, the smooth swelling between the eyebrows); g, gonion (angle of the lower jaw); L, inion (external occipital protuberance); L, lambda (junction of agittal and lambdoidal sutures); N, nasion (junction of the nasal and frontal); Ob, obelion (the agittal between the parietal foramina); P, pterion (point of junction of great wing of sphenoid and the frontal, parietal, and squamous bones. This may be H-shaped or K-shaped or "retourné," in which the frontal and temporal just touch); S, stephanion (or, better, the superior stephanion, intersection of ridge for temporal fascia and coronal suture); S', inferior stephanion (intersection of ridge for temporal muscle and coronal suture).

for a distance of three and three-eighth inches. Chiene finds the fissure of Rolando by the following method: He takes a square piece of paper and folds it into a triangle Fig. 446, 1); the angle B A C of this triangle is 45°;

the edge D A is folded back on the dotted line A E; the angle D A E equals half of 45°, or 22.5°, and the angle CAE equals the same (Fig. 446, 2); unfold the paper in the line CA; in the figure thus formed B A C =45° and E A C = 22.5°; E A B =67.5°, which is the angle desired. Place the point A in the mid-line of the head, over the point of origin of the Rolandic fissure; the side A B is laid along the middle line of the head, and the line A E corresponds to the fissure of Rolando.\* Horsley determines the situation of the Rolandic fissure by the use of his metal cyrtometer (Fig. 447). He places the point marked zero over the inioglabellar line and midway between the inion and the

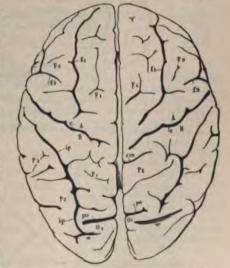


Fig. 443.-View of the brain from above (Ecker).

glabella. To find the fissure of Sylvius (Fig. 444, S, S', S"), draw a line from

<sup>\* &</sup>quot;American Text-Book of Surgery."

the external angular process to the occipital protuberance. The fissure of

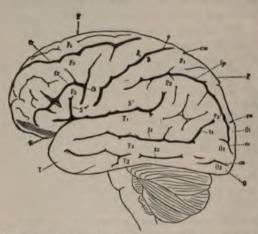


Fig. 444.—Outer surface of the left hemisphere of the brain (Ecker).

Sylvius begins on this line one and one-eighth inches behind the external angular process; the main branch of the fissure runs toward the parietal eminence; the ascending branch of the fissure corresponds to the squamososphenoidal suture, and continues upward in the same line half an inch above the suture. The precentral sulcus (Fig. 444, F) limits anteriorly the ascending frontal convolution; it runs parallel with and just behind the coronal suture, and a finger's breadth in front of the fissure of Rolando. The intraparietal fissure (Figs. 443,

444, ip) limits the ascending parietal convolution posteriorly. It begins oppo-

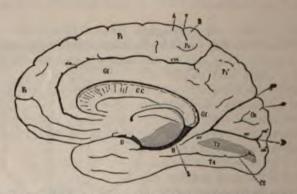


Fig. 445.-Inner surface of the right hemisphere of the brain (Ecker).

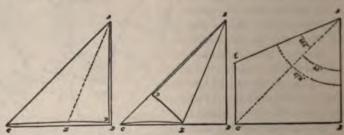


Fig. 446.—Chiene's method of fixing position of Rolandic fissure ("American Text-book of Surgery").

site the junction of the lower and middle thirds of the fissure of Rolando, passes

upward in a line parallel with the longitudinal fissure and midway between the Rolandic fissure and the parietal eminence, passes by the parieto-occipital fissure, and downward and backward into the occipital lobe. The motor areas, which on

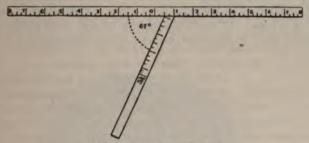


Fig. 447.-Horsley's cyrtometer.

the outer surface are adjacent to the fissure of Rolando, are shown in Figs. 443 and 444.\* The superior longitudinal sinus is overlaid by a line from the inion to the glabella. The lateral sinus is indicated by a line running from the occipital

protuberance horizontally outward to a point one inch posteriorly to the external auditory meatus, and from this point by a second line dropped to the mastoid process. The suprameatal triangle of Macewen is bounded by the posterior root of the zygoma, the posterior bony wall of the auditory meatus, and a line Joining the two. The mastoid antrum is Opened through Macewen's triangle to avoid injury to the lateral sinus. Barker's point, the proper spot to apply the trephine in ab-Scess of the temporo-sphenoidal lobe, is one and one-fourth inches above and one and onefourth inches behind the middle of the external auditory meatus. Fig. 448 shows clearly the main points of craniocerebral topography, Obtained by methods approved by many scientists.

Krönlein's method of localizing certain Points is the most generally serviceable. (See Fig. 449.) A line, known as the base line, 2 M, is carried horizontally backward from the lower border of the orbit through the upper border of the external auditory meatus. Another horizontal line, K K', is drawn parallel with this, on a level with the supra-orbital fidge. A line z K is erected from the middle

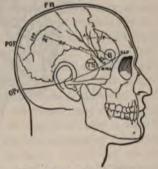


Fig. 448.-Head, skull, and cerebral fissures; B Corresponds to Broca's convolution; EAP, external angular process: FR. fissure of Rolando: IF. inferior frontal sulcus; IPF, intraparietal sulcus; MMA, middle meningeal artery; OPr, occipital protuberance; PE, parietal eminence; POF, parieto-occipital fissure; SF, Sylvian fissure; A, its ascending limb; TS, tip of temporo-sphenoidal lobe. pterion (to the left of B) is the region where three sutures meet, viz., those bounding the great wing of the sphenoid where it joins the frontal, parietal, and temporal bones (adapted from Marshall by, Hare).

of the zygoma to the supra-orbital line. A vertical line is drawn from the articulation of the lower jaw, A, and is prolonged to R. A vertical line is

\* Recent studies indicate that the motor region is entirely in front of the Rolandic fissure.

drawn from the posterior border of the mastoid base (M K') and is taken the middle line of the skull. A line is drawn from K to P, and between points R and P' it overlies the fissure of Rolando. The angle of P K K bisected by the line K S, which corresponds to the fissure of Sylvius from point of bifurcation to its posterior termination. K marks the bifurcation the fissure of Sylvius. To reach the anterior branch of the middle meninger artery trephine at K; to reach the posterior branch, trephine at K'.

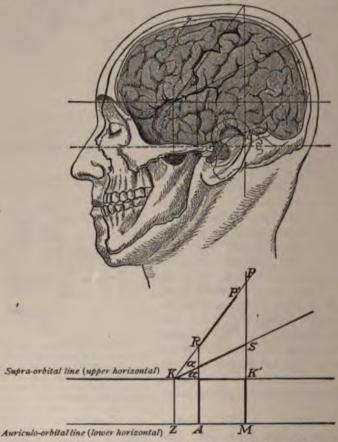


Fig. 449.—Krönlein's method of locating the fissures of Rolando (RP') and Sylvius (KS); Krönlein's point of trephining for hemorrhage from the middle meningeal (KK'); and von Bergmann's region for trephining for abscess of the temporo-sphenoidal lobes (AaK'M) ("American Text-book of Surgery").

Head Injuries During Labor.—Caput Succedaneum.—This condition is edema of the scalp due to prolonged pressure. The edema is circular and circumscribed and occupies the part not subjected to continued pressure during the uterine contractions of labor. The ring of tissues which are impressed around project like a cup into the birth canal. The veins become congested and edema results. The parts subjected to pressure may appear normal or may exhibit ecchymoses or even exceriations. The pressure is

because the most frequent presentation is left occipito-anterior, the common position of the caput is over the superior and posterior portion of the right parietal bone. In a face presentation great disfigurement may occur. It is alound that a double caput is encountered. It always means that the presentation has shifted. The worst cases of caput follow prolonged labor. The ematous swelling contains bloody serum, pits on pressure, does not flucture, is not limited to the outline of one bone, and the skin above it is usually also colored by ecchymoses. No treatment is necessary, as the condition all disappear in from a few hours to three days.

Cephalhematomata.—By this term we mean extravasations of blood beneath the untorn pericranium. It is supposed by many to be always due pressure and venous congestion, as is a caput succedaneum. As Cushing points out, the condition cannot result only from the venous stasis of prolonged Pressure. If it did it would always exhibit above it a caput succedaneum and this is far from our actual experience" (Harvey Cushing, in "Keen's Surgery," vol. iii). It is certainly due in some cases to bending or breaking of cranial bone. The condition is said to occur in 1 labor out of 200. In most ses there is but one cephalhematoma, but there may be two, three, or en four. The commonest situation is over the right parietal bone (the rumon seat of caput succedaneum) and caput succedaneum may be assoa ted with a cephalhematoma. The blood begins to flow beneath the perinium during labor and the swelling increases during the first few days after birth; in fact, it is frequently not noticed for a day or two. The swelling is tense and smooth with a convex outline. It may cover but a small portion a bone or an entire bone, but never extends beyond the bounding sutures. This limitation is due to the fact that the pericranium is adherent to the Sutures. In the course of a couple of weeks the tumor may become surrounded by a hard ring due to the formation of new bone, and a shell of bone may eventually surround and cover over the clot, an area of permanent bony thickening remaining. In other cases no bone forms, but the clot gradually disappears. An extradural and even a subdural cephalhematoma may be associated with a subpericranial cephalhematoma.

Cephalhematomata unassociated with cerebral symptoms usually disappear without operation. If there is no sign of subsidence after two weeks, follow cushing's rule, evacuate by a puncture-like incision and apply pressure. If suppuration occurs, incision is necessary. Suppuration may occur if the scalp was excoriated.

Diseases of the Scalp.—The scalp is composed of skin, subcutaneous fat, and the occipitofrontalis muscle and aponeurosis. The scalp is liable to inflammation from various causes, and also to other diseases—namely, tumors, cysts, warts, moles (local cutaneous hypertrophies), cirsoid aneurysm (page 432), nevi, and lupus. Abscesses of the scalp are common. If an abscess forms beneath the pericranium, the pus diffuses over the area of one bone, being limited by the attachment of the pericranium in the sutures. If an abscess forms in the tissue between the occipitofrontalis and the pericranium, it is widely diffused. Treves calls this subaponeurotic connective tissue "the dangerous area." Abscess of the subcutaneous tissue is apt to be limited because of the great amount of fibrous tissue. Abscess is treated by instant incision at the most dependent part, and drainage.

Diseases and Malformations of the Bones of the Skull.—The bones of the skull are liable to caries, necrosis, osteitis, periostitis, atrophy,

hypertrophy, tumors, etc. (see Diseases of Bones).

Cranial Pneumatocele.—This rare condition is a result of perforation of a bone which permits air to collect beneath the periosteum. It may occur in the mastoid or occipital region or over the frontal region. These protrusions vary greatly in size; and as their shape depends upon the periosteal attachment to sutures in the neighborhood, they vary in shape. The overlying tissues are natural in appearance. The protrusion is tense, but may lessen or disappear on pressure. McArthur points out ("Jour. Am. Med. Assoc.," May 6, 1905) that if diminished by pressure, the patient may hear a sound like rushing air or water in the ear if the protrusion is occipital or mastoid; and in the nose, if it is frontal. An elevated ridge of bone surrounds a pneumatocele. The protrusion is tympanitic on percussion. The condition is due to perforation of the bony wall of an air sinus by disease or injury or rupture. McArthur points out that in half of the reported cases the rupture was not preceded by any history of inflammation or injury. The condition is not dangerous.

Treatment.—Incision, finding the opening, enlarging it, removing osteophytes; bringing the walls of the cavity together and applying pressure.

Microcephalus.—By microcephalus is meant unnatural smallness of the head due to imperfect development. Marked microcephalus is not a common condition, but it is an occasional cause or associate of idiocy. A child may be born with a skull completely ossified even at the fontanelles. or the ossification may become complete soon after birth, but in many cases of microcephalus ossification takes place late or not at all. In microcephalus the face is usually fairly well developed; the jaws are prominent; the forehead is flat; the cranium and brain are small; the convolutions of the brain are simpler than is natural; there is apt to be marked asymmetry of the two sides of the brain; internal hydrocephalus may exist; areas of sclerosis and atrophy are common; porencephaly is not unusual. Some patients have perfect motor power; others are slow and incoordinate. Epilepsy, chorea, and athetosis frequently complicate the case. Idiots of this type often present deformities such as cleft palate, strabismus, distorted ears, hypertrophied tongue, deformed genitals or extremities, ill-shaped and irregularly developed teeth. They exhibit irregular muscular movements, are frequently paralyzed in childhood (infantile paraplegia or hemiplegia), and suffer from subsequent contractures. They are active, destructive, excitable, and are liable to be violent and almost demoniacal. As Clouston says, they look impish and unearthly.

Treatment.—Skilled training in a school for the feeble-minded or in an institution for idiots is necessary in treating microcephalic idiocy. Idiots have but little power of attention, and sensory impressions give rise to but few concepts, and these are feeble and fleeting. In order to educate the idiot it is highly desirable that speech be acquired, and "the more strongly the attention can be aroused, the more perfect does speech become" (Kirchhoff). The principle of the education of idiots is to stimulate, coördinate, and guide sight, hearing, and feeling.

Lannelongue, of Paris, has suggested an operation in cases of idiocy

with premature ossification (see Linear Craniotomy, page 849). In this procedure the author has no confidence. Idiocy is a general disorder and not a local brain disease. Soft parts mould bone, and bone does not control soft parts. There is no evidence that the brain is being compressed; in fact, the simplicity of the convolutions suggests the contrary. In many typical cases of microcephalic idiocy there is no synostosis even years after birth. The operation has been much abused. It is sometimes fatal, and, although a fatality may gratify the family, a surgeon is not a legal executioner. The remarkable improvement which has been reported in some cases is wrongly supposed to be due to the operation. As a matter of fact, the new surroundings, the strange faces, the firm discipline, the effect of the anesthetic, and the shock of the operation attract the feeble attention and rouse the sluggish senses. Many cases are brought for operation because they are for the time being unusually intractable and excitable, and the return to the usual level of conduct after operation is regarded as a permanent gain, when it is often but a temporary alleviation. We believe that scientific training is the proper treatment, and that the efficiency of training is not increased by the previous performance of craniotomy, and we follow the precept of Agnew, that a surgeon might as well cut a piece out of a turtle's back to make a turtle grow as to cut a piece out of the skull to make the brain grow.

Diseases and Malformations Involving the Brain.—Cephaloceles.—A cephalocele is a congenital protrusion of intracerebral contents through a defect in the skull. These protrusions are covered with skin. The defect through which the protrusion occurs is always in the median line, although in some cases (as at inner angle of the orbit) the visible protrusion may be at the side. Nearly all such protrusions are either frontal or occipital, although now and then one presents in the pharynx, having emerged from the

skull between the body of the sphenoid and the ethmoid.

Frontal cephaloceles are divided into:

1. Nasofrontal—those which are in the region of the glabella.

2. Naso-orbital-those at the inner angle of the orbit.

3. Nasoethmoidal—those below a nasal bone.

Each one of the above forms passes through the horizontal plate of the ethnoid.

Occipital cephaloceles are divided into:

1. Superior—those above the external occipital protuberance. In these the bony gap may join the posterior fontanel.

2. Inferior—those below the external occipital protuberance. In these

the bony gap may join the foramen magnum.

The above regional classification is that advocated in von Bergmann's "System of Practical Surgery" (translated and edited by Wm. T. Bull and Walton Martin).

The commonest form is hydrencephalocele, and all other forms result

from retrograde changes in this.

Hydrencephalocele.—This is by far the commonest and is also the most dangerous form encountered. The protrusion consists of arachnoid, a layer of brain tissue, and a cavity containing ventricular cerebrospinal fluid and connected with the lateral ventricle. It is in reality a protrusion of the lateral ventricle. It is covered with skin—natural skin, unless the protrusion

is very large, in which case the skin is more or less atrophied. Beneath the skin is fascia and beneath this, arachnoid. The pericranium and dura do not cover it, but each has a gap in it and these two tissues join each other around the bone margins.

Encephalocele.—Results from retrograde changes in a hydrencephalocele. The protrusion of the ventricle has become reduced and the hernia consists of a portion of brain covered by arachnoid. Encephalocele is only seen in the nasofrontal region. If there is any fluid in this protrusion, it is not in its interior, but on its surface, and results from a cyst of the arachnoid.

Meningocele.—We formerly understood by a meningocele a protrusion of the membranes alone; we now regard it as a condition resulting from retrograde changes in a hydrencephalocele. The brain tissue of the latter disappears; beneath the arachnoid is a layer of cells identical with those which line the ventricles; the connection with the ventricle is entirely or almost completely cut off; a cyst forms in the subarachnoid tissue, and thickened pia surrounds the cyst. (See "System of Practical Surgery," by E. von Bergmann, vol. i, translated and edited by Wm. T. Bull and Walton Martin.) The above condition is called by von Bergmann encephalocysto-meningocele.

Diagnosis.—The congenital origin and situation make certain that the condition is cephalocele. The bony gap can usually be felt; whether it can or cannot, an x-ray picture should be taken. Such a picture may indicate that the mass contains brain matter. The protrusions vary greatly in size and shape. Some are rounded, some are flattened, some are stalked. The skin covering them may be natural, atrophied, filled with vessels, scarred, or ulcerated. times the cephalocele is very tense; sometimes it is loose. In naturally hairy regions the skin over the summit of the protrusion is bald, but that around the base is hairy. If there is connection between the interior of the protrusion and the ventricle, the mass can be diminished in size by compression. If it shrinks rapidly from compression, the opening into the ventricle is large. In such cases compression of the mass quickly causes signs of cerebral pressure. Lumbar puncture may cause the protrusion to diminish in size; crying may cause it to increase in size. Large cephaloceles fluctuate and perhaps pulsate. Meningocele feels and looks like a cyst (is translucent and fluctuates); it does not usually pulsate, it has a small base, it becomes tense on forcible expiration, and some cases can be very slowly diminished by compression.

Encephalocele is small, opaque, does not fluctuate, has a broad base, does pulsate, becomes tense on forced expiration, and attempts at reduction fail and cause pressure symptoms.

Hydrencephalocele is larger than a meningocele, is translucent, fluctuates, rarely pulsates, is pedunculated, is rendered a little tense on forced expiration, and can be lessened in size by compression but cannot be reduced.

Treatment.—In von Bergmann's "System of Practical Surgery" we find the wise caution to attempt no operation for an occipital protrusion beneath the protuberance, when the cleft enters the foramen magnum and is associated with cleft of the cervical vertebræ—for a condition in which the soft parts are defective and the brain is exposed (cranioschisis)—on a case complicated with hydrocephalus or on a case complicated by some other condition which is of necessity fatal. We no longer refuse to operate because the mass contains some brain matter or because it communicates with the ventricle.

although if it does so, the prognosis is much worse. For a large hydrencephalocele nothing can be done and early death is inevitable. In rare instances an encephalocele is converted into a meningocele, and the bony aperture closes, thus bringing about a cure. Among the expedients for treating meningocele are electrolysis, injection of Morton's fluid (gr. x of iodin, gr. xxx of iodid of potassium, 5 j of glycerin), pressure, and excision. In cases of cephalocele, when portions of the nerve-centers are not contained in the sac, A. W. Mayo Robson advises the performance of a plastic operation. He ligates the neck of the sac, excises the sac, sutures the skin-flaps separately, and leaves the stump outside the line of superficial sutures. It is usually possible to tell by palpation if nerve-centers are in the sac, but if in doubt, make an exploratory incision, and sweep the finger around inside of the sac.\* Meningoceles should be operated upon by Robson's plan.

Spurious Meningocele.—It occasionally happens, after a fracture of a child's skull, that cerebrospinal fluid gathers beneath the pericranium and bulges the pericranium and scalp. This condition is called spurious meningocele. When a spurious meningocele forms, the bone must have been broken and the dura and arachnoid ruptured. This protrusion fluctuates, pulsates, and is influenced by respiration. In some cases there is communication with the ventricles of the brain. The parietal and frontal regions are the most usual seats of the trouble. The opening in the skull may close; it may remain stationary; it may actually enlarge by bone-absorption. In some cases the spurious meningocele undergoes spontaneous cure; in some cases rupture occurs; in other cases death takes place as a result of the cerebral injury. (See Joseph Sailer on "Spurious Meningocele," "University Med. Magazine," Sept., 1900.)

Treatment.—Close the opening by a plastic operation.

Hydrocephalus.—In external hydrocephalus the fluid is on the surface of the brain; in internal hydrocephalus the fluid is in the ventricles. Hydrocephalus may be acute or chronic, congenital or acquired.

Acute hydrocephalus is usually internal, but may be external. It results from meningitis—usually tuberculous meningitis of the base. The symptoms are headache, elevated temperature, delirium, stupor, convulsions, paralysis, and choked disc.

Treatment of acute hydrocephalus by medical means is of no avail. Tap-

ping of the ventricles may be tried.

Chronic internal hydrocephalus is usually congenital, but may arise after birth in children under seven. In congenital hydrocephalus the condition may be due to circulatory disturbances in the brain of the embryo resulting from uterine disease or injury during pregnancy. Syphilis and alcoholism in parents seem sometimes to be responsible. Chronic acquired hydrocephalus results from inflammation, especially tuberculous inflammation. A tumor pressing on the veins of Galen may cause it. In chronic acquired internal hydrocephalus there is overproduction or underabsorption of cerebrospinal fluid and perhaps both conditions may exist. The usually causative condition is an inflammation of the interior of the ventricles, particularly of the choroid plexuses, and as a consequence venous return is obstructed and oversecretion occurs. One or both foramina of

<sup>\*&</sup>quot;Amer. Jour. Med. Sciences," Sept., 1895.

Monro may be closed, and if only one is closed, unilateral hydrocephalus may arise (Alfred S. Taylor, in "Am. Jour. of Med. Sciences," August, 1904). The aqueduct of Sylvius, the foramen of Magendie, and the central canal of the cord may be occluded. The cranium enlarges enormously and the bones of the skull are widely separated. The brain is distended and thinned and the sulci are obliterated. The broad forehead overhangs the eyes; the fontanelles are elevated. The child is mentally weak or is an idiot, and very often does not learn to walk or to talk. Convulsions, palsies, and contractures are common, and blindness is frequent. Such children usually

die voung.

The treatment of chronic hydrocephalus is rarely of much avail. Pressure by strapping with adhesive plaster has been tried. Tappings through a fontanelle may be performed by means of a trocar (only 3ij or 3iij of fluid being withdrawn at a time). If much fluid is allowed to flow out, the head must be strapped with adhesive plaster afterward. If the skull ossifies, the lateral ventricles may be tapped after trephining. It has been proposed to drain by tapping the theca of the spinal cord (Quincke). This last operation is called lumbar puncture (pp. 878, 879). It will, of course, fail if the foramina in the floor of the fourth ventricle or the aqueduct of Sylvius are blocked. Even if they are open, it is of little service. The operation which promises most was devised by Sutherland and Cheyne, and is known as intracranial drainage ("Brit. Med. Jour.," Oct. 15, 1898). Their theory is that in hydrocephalus fluid distends the ventricles because the channels of communication between the ventricles and the subarachnoid spaces are closed. The subarachnoid spaces communicate directly with veins, hence fluid cannot collect under pressure in these spaces. Intracerebral drainage establishes a communication between the subarachnoid space and one ventricle. It is not necessary to operate on both sides in bilateral hydrocephalus, because the lateral ventricles communicate. A small opening is made in the skull. The dura is incised. A number of strands of catgut, which are tied together, are pushed through the brain so that one end of the catgut mass lies in a ventricle and the other end beneath the dura. The dura and scalp are then sutured. Brewer makes an osteoplastic occipital flap, makes a dural flap, lifts the cerebral lobe, and pushes a drain of rubber tissue into a lateral ventricle,

The elder Senn passed a rubber tube into the ventricle and put the outer

end of the tube beneath the skin of the scalp.

Alfred S. Taylor ("Am. Jour. Med. Sciences," August, 1904) makes an osteoplastic flap with its base over the right mastoid, cuts a dural flap, passes a slender aspirating needle through the second temporo-sphenoidal convolution into the lateral ventricle, draws off a little fluid, and measures the thickness of the brain. He then takes 6 strands of No. 2 forty-day catgut, each strand half an inch longer than the thickness of the brain. The strands are tied together with a spiral of catgut, 14 inches of the loop being left free. Three layers of Cargile membrane are wrapped about the shaft, but the tip remains free. It is carried into the ventricle along the needle track by thumb forceps, and the loops are slipped here and there, but chiefly downward, under the dura. Cargile membrane is placed between the loops and dura and the dura and skin are sutured. Taylor operated on 6 cases and 2 recovered, with relief of all signs of pressure.

Cushing, after determining by lumbar puncture that the ventricles can be emptied, obtains retroperitoneal drainage by a combined laparotomy and laminectomy.

## INJURIES OF THE HEAD.

Caput Succedaneum.—(See page 790.)

Scalp-wounds.—Scalp-wounds bleed profusely because the scalp is very vascular, because many of the blood-vessels are in fibrous tissue and cannot contract and retract, and because even blunt force splits the scalp almost like an incision. Scalp-wounds are treated as are other wounds. Even a large piece of scalp with only a narrow pedicle may not slough; hence try to save any piece that has an attachment. Always shave a wide area and disinfect the shaven area and the wound. Arrest hemorrhage, and exercise great care in cleansing the wound and the parts about it. Stitch the wound with silkworm-gut. Very few sutures are needed if the wound is longitudinal, but many are required if it is transverse. The permanent arrest of hemorrhage is rarely effected by ligatures, but rather by sutures judiciously placed. If drainage is required, use a few strands of silkworm-gut; but drainage is rarely used unless we know the wound is grossly infected. Wet antiseptic dressings are used for the first few days and moderate pressure is applied by wet gauze bandages. Avulsion of the scalp is discussed on page 275.

Contusions of the Head.—Scalp-swelling from hemorrhage is usually considerable. The patient may be stunned or dazed. The swelling of hematoma must not be mistaken for *fracture* with depression. In hematoma there is a central depression; hard pressure on the center finds bone on a level with the general contour of the bone, and the margin of a hematoma is circular, is not quite hard, and is elevated above the general contour. In depressed fracture the edge is on a level with or below the level of the general bony contour, and the margin is sharp and irregular. The treatment is

by bandage-pressure. If suppuration arises, at once incise.

Concussion, Contusion, and Laceration of the Brain.-For many years it was customary to regard concussion as a condition produced by molecular vibrations in the nervous substance of the brain. Duret's classical observations profoundly modified surgical thought, and led to the opinion that in concussion of the brain there is injury to the brain itself, a rupture of cerehral vessels brought about by the advance and recession of a wave of cerebrospinal fluid. This wave, it is thought, first flows in the direction of the force. Keen says that there may be slight brain injuries which can properly be talled "concussions," but it is better to consider concussion as synonymous with laceration of the brain. Kocher considers concussion as identical with contusion of the brain. It seems, however, highly improbable that slight cases of concussion are accompanied by vascular rupture or organic misthief; the symptoms are too transitory, and reaction too rapid and complete to permit of any such view. Experiments on animals show we can develop concussion without laceration or contusion. Autopsies have been carefully made in some cases of death from concussion, and no organic lesion has been discovered. It is quite true that the same force which causes the concussion may cause contusion or multiple lacerations, and a severe force is apt to do so. But we are not then justified in assuming that concussion is contusion or laceration; we should rather conclude that the individual had both concussion and a demonstrable injury. Both conditions arise from violence, but the two conditions are not identical. I believe with von Bergmann that there is such a condition as concussion, which may be pure concussion or may be associated with organic damage, and even if a man dies and is found to have an organic injury, the concussion may have caused, or, at least, have hastened, the fatal result. I believe with von Bergmann that it is not repeated waves of force from the blow but the concussion of the blow itself that does the harm. The brain is momentarily displaced by the blow. The blow acts on the entire brain; the centers are first stimulated and then depressed, and in fatal cases are not only depressed but are paralyzed. The cause of concussion is violent force either direct (as a blow upon the head) or indirect (as a fall upon the buttocks). This force shakes, oscillates, jars, or displaces the brain, giving rise to stimulation and then to exhaustion of the nerve-centers, and perhaps to rupture of vascular twigs, large vessels, or even the membranes. In the less severe cases concussion only exists; in the more severe cases there is also contusion or laceration or compression soon arises.

As von Bergmann points out, the entire cortex in concussion is momentarily stimulated and then depressed. The momentary stimulation exists when a man "sees stars" as a result of a blow. The depression or exhaustion is manifested by heaviness, dulness, stupor, perhaps by unconsciousness. The stimulation of the medullary centers, von Bergmann points out, lasts longer, as a rule, than the stimulation of the cortex, and is manifested particularly by a slow pulse. If the pulse grows rapid and weaker, the pneumogastric center is becoming exhausted and the patient is in danger of death. In slight cases of concussion only the cortex may be involved, the medullary center escaping. In rapidly fatal cases of concussion the medullary centers are quickly

paralyzed.

Symptoms.—In very trivial cases the patient is slightly and momentarily dazed and the pulse is temporarily slow and weak, but he is otherwise unaffected. In a rather slight case of brain concussion the patient may or may not fall; his face is pale; he feels weak, giddy, nauseated, and confused; but he soon reacts, and often vomits. The pulse is weak and is slow for a time and then becomes normal. In a severe case he lies in a state of complete muscular relaxation. The extremities are cold; the skin is pale and cold; the pulse is small, soft, slow, and weak, because of stimulation of the pneumogastric center; the respiration varies, being sometimes deep, sometimes superficial, sometimes rapid, and sometimes irregular. He seems unconscious, but can usually be roused to monosyllabic response by shouting, pinching, or holding a bright light near his face. Occasionally, however, there is complete unconsciousness. The urine and feces are often passed involuntarily. The pupils may be unaltered, may be dilated or contracted, may be equal or unequal, but in any case they will react to light. Paralysis rarely exists, but if there is paralysis, it is temporary. The temperature at first is subnormal. In a very severe concussion in which there is great danger of death the pulse is very rapid, small, weak, and probably irregular because of exhaustion of the medullary center, and the patient is absolutely unconscious because of depression of the cortex. In a severe cortical laceration there will be twitchings or even general convulsions, or the patient will lie curled up with limbs flexed and

evelids shut, and will resist all attempts to open his eyes or mouth or to move his limbs (A. Pearce Gould). Erichsen called this condition "cerebral irritability." If a patient with very severe concussion and very rapid pulse is going to get better, the pulse will become slower. If a patient with severe concussion and a slow pulse is improving, the pulse will become normally rapid andstronger; if he is getting worse, it will become abnormally rapid and weaker. How long may concussion last? As von Bergmann well says: Concussion is transient in its manifestations. It is a matter of a few minutes or at most a few hours, and any prolongation of severe symptoms beyond this time, especially if they are intensifying as time goes on, indicates an associated injury. When the patient reacts from concussion, he will most probably vomit. Within twenty-four hours he usually improves, but is feverish and complains of headache and lassitude, sometimes becomes delirious, and in rare cases develops mania. After concussion recovery may be complete, but, on the contrary, a person's whole nature may change: he may develop hysteria, insanity, or epilepsy, and in many cases there is complaint for a long time of headache, insomnia, low spirits, and lassitude. Concussion may pervert or wipe out all memory of the causative accident and also, strange to say, of a varying period preceding the accident. The loss of memory of the accident is permanent; the amnesia for a period preceding the accident may be permanent, but may only be temporary. Statements made regarding an accident by those who have had concussion must be received with many grains of salt. If the patient in concussion recedes from, instead of advancing toward, recovery, coma will set in or inflammation will develop. The prognosis is always uncertain. Any concussion producing more than very temporary unconsciousness is almost surely a serious injury, because considerable laceration has probably occurred.

Treatment.—In treating brain concussion bring about reaction by the administration of aromatic spirits of ammonia (no alcohol, as this agent excites the brain), by pouring a few drops of ammonia on a handkerchief and holding it near the nose, by surrounding the patient (who lies in bed with a pillow) with hot bottles, by hot irrigation of the head, by the application of mustard over the heart, and by the administration of enemata of hot coffee or hot saline fluid. Do not pour fluid into the patient's mouth until he becomes able to swallow easily. If he cannot easily swallow, rely on hot enemata and hypodermatic injections of strychnin. Place the patient in bed in a quiet room and watch him. If reaction is inordinate, apply cold to the head, give arterial sedatives and diuretics, and purge. For some days or for some weeks, according to the case, insist on an easy life. For many weeks after a grave concussion a patient must be kept away from business and be watched, because of the possibility of an abscess of the brain arising, and because of the liability of such patients to develop hysteria, neurasthenia, or insanity. Give a plain diet containing a minimum of meat, administer an occasional purgative, and securesleep. Sleep can often be obtained by some simple expedient, such as the administration of warm milk, placing a hot-water bag to the abdomen or feet, or applying a mustard plaster for a short time to the back of the neck. In cases where obstinate wakefulness exists, it becomes necessary to give bromid, chloral, sulphonal, trional, or some other hypnotic. Morphin is avoided because it is thought to increase venous congestion of the brain, but the elder Gross often used it, especially in cerebral irritation. If signs of compression arise, it is best to trephine, as the compressing agent may be a clot (see page 804). If inflammation arises, some surgeons will not trephine; but it is wise and proper, especially if the damage seems to be localized, to incise the scalp and inspect the bone. If a fracture is discovered and the symptoms are serious, perform an exploratory trephining, open the dura, and secure drainage for inflammatory products.

In any severe concussion of the brain with contusion of the scalp the sur-

geon should at once incise the scalp and inspect the bone.

Compression of the Brain.—The combination of symptoms indicative of cerebral compression may be present in a number of different conditions. We find these symptoms in abscess of the brain, tumor of the brain, intracranial hemorrhage, foreign bodies, inflammatory exudate, and fracture of the skull with marked depression. The symptoms of compression are expressive of impairment of the functions of the entire brain by insufficient and imperfect circulation of blood, this impairment of circulation being the result of a lessening in capacity of the cavity containing the brain, its membranes, the blood-vessels, and the cerebrospinal fluid (von Bergmann). If a brain tumor, or abscess, or blood-clot, or portion of depressed bone occupies space previously given to brain matter, vessels, etc., there is less room within the skull to contain the special structures; they are squeezed and the circulation is greatly impeded. This condition is compression. The circulation is slowed, and because of slow circulation the activity of the centers is finally inhibited. It is stated by Cushing that the rise which occurs in the blood pressure is conservative and is expressive of nature's effort to maintain the circulation in the compressed medullary centers. The cortex is temporarily stimulated and then depressed, because of impairment of nutrition. The medullary centers are first stimulated. The respiratory center is stimulated by retention of CO, in the blood, then the vasomotor center is stimulated, then the vagus, and finally, perhaps, the convulsive center (von Bergmann's "System of Practical Surgery"). The stimulation of the cerebral centers is followed after a time by weakening or actual paralysis. centers are said to suffer in regular order, viz., the cortex, the corona radiata, the gray matter of the cord, and, finally, the medulla (Huguenin). As von Bergmann points out, by the time the convulsive center becomes stimulated. the cortex is usually exhausted and the patient is unconscious. In compression the sensitive cortex first feels the effect and feels it most gravely, and the cortical impairment may last long after other trouble has passed. In some cases the cortex alone seems to be distinctly involved. When the vagus center is stimulated, the pulse becomes slow; later, as the center becomes exhausted. it becomes rapid and weak, and this change has the same unfavorable significance as in concussion. If death occurs it results from paralysis of respiration and not of circulation.

Symptoms.—The symptoms, known as pressure symptoms, are divided into those occurring during the period of stimulation and those occurring during the period of increasing exhaustion. The symptoms of the first stage are headache, vomiting, flushing of the face, contraction of the pupils, choked

disc, mental excitement, elevation of blood-pressure, restlessness, and slowing of the pulse. The pulse becomes slow, regular, and strong. The symptoms of the second stage are heaviness, dulness, drowsiness, passing into stupor, and finally into coma. The respirations are stertorous and after a time become Cheyne-Stokes. The pulse is weak, intermittent, compressible, and increasingly rapid. There are involuntary evacuations of feces and urine, and finally paralysis of respiration which causes death, the heart beating for a time after respiration has ceased (von Bergmann's "System of Practical Surgery").

The headache usually present in the first stage of compression is intense, persistent, sometimes general and sometimes more or less localized, and often aggravated by percussion of the cranium. It persists even in delirium, and the patient ceases to appreciate it only when unconsciousness begins. The vomiting is usually without nausea and is due to stimulation of the medullary center. At first vomiting may arise from taking food, but it soon continues independent of food. The tongue is probably clean. Cerebral vomiting is usually associated with severe headache. Restlessness is a pressure symptom in the stage of stimulation, and the patient rolls his head, tosses his body, and groans with pain. The heart does not begin to slow until the patient begins to be dull and drowsy, or until stupor arises, when the pulse slows and the tension rises. Finally it becomes very slow—perhaps less then 40 in a minute. If the condition grows worse, the pulse after a time suddenly becomes rapid and of low tension instead of slow and of high tension, a most unfavorable sign, indicating exhaustion and approaching paralysis of the vagus. In the stage of stimulation the patient is excited, unstable, delirious, and the condition of delirium gradually gives way to drowsiness, stupor, and coma. In some cases of compression there is distinct protrusion of the eyeballs. Before the patient is unconscious the pupils are contracted. When the patient is comatose, they are usually dilated, but may be contracted and respond slowly to light or not at all. If the conjunctival reflex is gone, they will not respond at all (Gowers). In a lesion making unilateral compression toward the base, the pupil on the side of the compressing cause is apt to be much dilated and even immobile. Choked disc begins in the stage of stimulation and continues to the end. That choked disc is due to intracranial pressure seems demonstrated by numerous operation reports, especially by Cushing, of Johns Hopkins Hospital, in which relief of pressure abates choked disc (see page 828). The existence of choked disc is determined by the use of the ophthalmoscope. The respirations become stertorous or snoring as coma develops because of the vibrations of the relaxed palate in the air-current, and the cheeks flap during expiration. As the activity of the respiratory center fails from increasing anemia, the respirations become shallow and infrequent, or, perhaps, of the Chevne-Stokes type. Gowers defines Cheyne-Stokes breathing as "alternating periods of decreasing and increasing depth of breathing, separated by a pause" (Lectures on Diseases of the Brain). The unconsciousness of compression may be sudden or gradual, may be partial or complete. Apoplexy and many traumatisms cause immediate unconsciousness. A meningeal hemorrhage causes a gradually increasing unconsciousness. A brain tumor may cause heaviness, dulness, stupor, or,

perhaps, after a long time, even coma. If compression comes on gradually, the brain more or less accommodates itself, and unconsciousness, if it occurs at all, is considerably deferred. A sudden increase of pressure may produce immediate unconsciousness. Stupor is partial unconsciousness, a condition in which a person lies as though asleep, though he rouses partially and temporarily when positively spoken to. In profound coma the limb reflexes are diminished or lost, the muscles are flaccid, and swallowing is impossible. In coma there is incontinence of feces and either incontinence or retention of urine. There may be the incontinence of retention. The temperature of a patient suffering from compression varies. In traumatic cases it may be at first subnormal and later normal or elevated. In inflammatory conditions it is elevated, except in abscess of the brain, in which it is subnormal in half the cases. After an apoplexy it is for a time subnormal, but as shock passes away it becomes somewhat elevated. Any sudden compression causes shock and temporarily subnormal temperature. Lesions of the pons and medulla cause elevation-perhaps remarkable elevation of temperature. In great or sudden brain compression complete coma always exists without voluntary movement. In cerebral compression paralysis may exist, which may be very limited (monoplegia), may be of one side (hemiplegia), or may be general. In hemorrhage into the interior of the brain the unconsciousness is immediate or nearly so. In bleeding from the middle meningeal artery a period of consciousness intervenes between the injury and the coma, in which period blood collects and the coma comes on gradually. In compression from depressed fracture or from a foreign

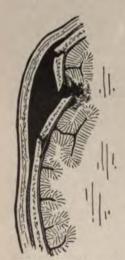


Fig. 450.—Fracture of skull with depressed fragments. Compression of brain by bone (Scudder).

body the symptoms usually come on at once, but they may be deferred for some hours. Compression from inflammation or pus begins gradually after a considerable time has elapsed. The symptoms described as pressure symptoms are those of pure compression. When traumatism causes the condition, the compression symptoms are mingled with those of concussion, or perhaps of contusion or hemorrhage. The brain adjacent to any lesion causing compression suffers more than the brain distant from it. The blood-supply of the entire brain is affected, but the adjacent brain has its capillaries particularly and directly compressed. Hence the paralysis sometimes produced by certain lesions. The course of compression depends on the nature and persistence of the cause. Great temporary pressure may produce no permanent harm. Moderately severe pressure may be recovered from even after weeks of stupor. Great pressure, sufficient to induce coma, if not relieved quickly, will cause death. Persistent cerebral symptoms after a head injury, when no obvious lesion can be made out, are probably due to edema of the brain.

Determination of the Cause of Coma in a Patient.—A diagnosis must be made between coma due to brain injury and the comatose condition

of apoplexy, uremia, epilepsy, hysteria, diabetes, opium-poisoning, and alcoholic intoxication. In hospital practice cases of unconsciousness without a known history are frequent. In attempting to diagnosticate, examine carefully for any evidence of traumatism, and inquire as to how and where the patient was found, if any fit occurred, and if a bottle or a pill-box was found near by or in the pockets. The surgeon should himself examine the pockets. Smell the breath to notice alcohol or opium, but always remember that a victim of Bright's disease is liable to apoplexy, that a man may be stricken with apoplexy while he is drunk, and may fracture his skull by falling when under the influence of opium or of alcohol. The odor of acetone (violets) on the breath or in the urine indicates the existence of diabetes. Draw the urine with the catheter if any water is in the bladder. Examine the urine for albumin, acetone, and sugar, and take the specific gravity. In doubtful cases of coma have an ophthalmologist use the ophthalmoscope. He might find optic atrophy indicative of Bright's disease or choked disc indicating compression. The cerebrospinal fluid obtained by lumbar puncture will contain blood if



Fig. 451.—Frontal section of skull. Middle meningeal hemorrhage. The dura bulges inwird toward the skull cavity (diagram) (Scudder).

in this condition cerebrospinal fluid is usually bloody. In post-epileptic

Refure in larger scales, plant britte in larger, of artery.

hemorrhage has taken place beneath the cerebral dura or in a ventricle of the brain. This test is valuable in fracture of the base of the skull, for

Fig. 452.—A case of rupture of middle meningeal artery. Preparation of dura. In the Warren Museum. The specimen is viewed from the outer side (Scudder).

the condition resembles sleep, and the patient can be aroused. Hysterical coma occurs in boys and women; there are no objective symptoms, and the patient, though swallowing what is put into his mouth, cannot be roused. In uremia, besides the condition of the urine (and always remember that a person with albuminuria is apt to develop apoplexy), there is a persistent subnormal temperature, and convulsions are prone to occur. There is perhaps edema of the legs, and paralysis and stertor are absent. In apoplexy hemiplegia exists, and the initial temperature is for a short time subnormal. A single convulsion may have ushered in the case. Alcoholic unconsciousness is often diagnosticated when apoplexy really exists. A man will smell of alcohol who has had one drink, but one drink will not produce coma; hence the smell of

alcohol is not conclusive. In any case of doubt some hours of watching will clear up the diagnosis. Regard a doubtful case as serious until the truth is clear. In opium-poisoning the pupils are contracted to a pin-point, the respirations are usually slow, shallow, and quiet, and may be stertorous, but there is no paralysis. Always remember that hemorrhage into the pons will produce pin-point pupils, but it also causes paralysis (crossed paralysis if in the lower half of the pons) and high temperature with sweating. In opium-poisoning the temperature is subnormal. In diabetic coma the pupils will react to a very bright light, the temperature is subnormal, and the breath and the urine smell of acetone.

Treatment of Brain Compression.—The treatment of brain-compression depends on the cause. Hemorrhage (extradural or subdural) requires trephining and arrest of bleeding; coma from depressed fracture demands trephining and elevation; foreign bodies must be removed; abscesses must be evacuated; some tumors are to be removed. In many tumor cases the growth is not removed, but a decompression operation is performed (page 850). In cerebral compression, if death is threatened by respiratory failure, make artificial respiration and at once trephine over the supposed region of compression. Horsley has shown that irrigation of the head with hot water is of great value in bringing about reaction from shock in cases of brain injury.

Intracranial hemorrhage may be either spontaneous or traumatic. In the vast majority of instances spontaneous hemorrhage comes from the lenticulostriate artery (Charcot's artery of cerebral hemorrhage), and produces apoplexy, a disease belonging to the physician, except in some ingravescent cases, for which ligation of the common carotid on the same side as the rupture may be indicated. In adults traumatism is almost always the cause of a meningeal hemorrhage. The blood may flow from a sinus, from the middle meningeal artery or one of its branches, or from vessels of the pia. Traumatism during delivery is an occasional cause of hemorrhage from the middle meningeal artery (Richardiére) and a not unusual cause of hemorrhage from cortical veins. Violent paroxysms of coughing in whooping-cough occasionally produce extradural hemorrhage or subdural hemorrhage. Geo. S. Brown reports such a case. He diagnosticated the condition and operated successfully ("New York Med. Jour.," April 25, 1903).

Traumatic Meningeal Hemorrhage.—Hemorrhage may take place—
(1) between the bone and the dura (extradural); (2) between the dura and the

brain (subdural); and (3) in the brain substance (cerebral).

1. Extradural hemorrhage arises usually from the middle meningeal artery or from one of its branches. A spicule of bone may penetrate a venous sinus and produce extradural hemorrhage, or a sinus may rupture. Rupture of the meningeal artery or one of its branches is usually, but not always, accompanied by fracture (Fig. 453); in fact, in some cases not even a bruise can be found (Fig. 452). The ruptured vessel may be upon the opposite side to that on which the force was applied, hence the evidence of scalp injury is not a certain sign of the side of the skull involved. The accident may or may not cause temporary unconsciousness; but even if it does, from this unconsciousness the patient almost always reacts, and there is a distinct period

of consciousness between the accident and the lasting coma, the coma being due to pressure from a continually increasing mass of extravasated blood (Fig.

451). If the main trunk or a large branch is ruptured, the period of consciousness is short; if a small branch is ruptured, the period of consciousness is prolonged for hours or perhaps for days. As the clot forms and enlarges the patient becomes heavy, dull, stupid, and sleepy; he sleeps so soundly he can scarcely be aroused, and snores loudly, and finally passes into stupor and then into coma. The other signs of this condition are paralysis of the side opposite the blood-clot (not necessarily of the side opposite the point of application of the force, for the artery may rupture from contre-coup on the uninjured side); this paralysis is apt at first to be localized, but it gradually and progressively widens its domain. If the clot extends toward the base, the pupil on the same side as the clot ceases to react to light, becomes immobile, and dilates widely, and, if the clot be on the left side, aphasia may be noted. As the clot enlarges adjacent centers become involved. The face becomes paralyzed, then the arm, and finally the leg. Not unusually epileptiform attacks occur, starting in discharges from the centers which are irritated by the advancing clot before their function is abolished by

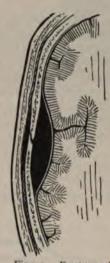


Fig. 453.—Fracture of skull with middle meningeal hemorrhage. Compression of brain by blood (Scudder).

pressure. The pulse becomes full, strong, usually slow, but occasionally frequent; the breathing becomes stertorous; the temperature rises, that of the paralyzed side exceeding that of the sound side. In a compound fracture the pressure of escaping blood may force brain matter out of the wound. In extradural hemorrhage from a sinus the symptoms cannot be differentiated from those produced by arterial rupture.

Treatment.—In treating extradural hemorrhage localize the clot, not by the seat of the wound or contusion, but entirely by the symptoms. In a doubtful case endeavor to bring about reaction; but if the state of shock deepens or does not improve and if pressure-symptoms increase, operate at once. To reach the middle meningeal artery or its anterior branch trephine one and one-fourth inches back of the external angular process, at the level of the upper border of the orbit (Figs. 441 and 449). If this incision does not expose the clot, trephine again at the level of the upper border of the orbit and just below the parietal eminence (Fig. 449). The first incision gives access to the main trunk and to the anterior branch; the second incision exposes the posterior branch. If signs indicate that the clot is traveling to the base, the trephine should be used half an inch lower than the point first directed. Arrest bleeding by a suture ligature or by packing (page 453), and always open the dura and inspect the brain. By this procedure a subdural hemorrhage may be discovered which, without it, would have been missed. Drainage must be employed.

2. Subdural hemorrhage is usually due to depressed fracture and rupture of the middle cerebral artery or of a number of small vessels. The symptoms are identical with those of extradural bleeding, but are usually very rapid in

onset and are accompanied by a more distinct drop in temperature graver depression. The cerebrospinal fluid obtained by lumbar pun is bloody.

The treatment is trephining at the first point named in the previous ar enlarging the opening upward and backward with a rongeur, opening dura, turning out the clot, ligating the bleeding point or packing, elevating depression of bone, draining, and stitching the dura with catgut. He rhage from internal pachymeningitis requires the same treatment.

3. Cerebral Hemorrhage.—The symptoms of cerebral hemorrhage identical with those of apoplexy. The treatment is the same as that for plexy, except in ingravescent cases, when the common carotid on the

side as the clot may be ligated.

Rupture of a sinus may arise without a bone injury, but is usually to a compound fracture. A sinus may be wounded during a brain opera. The treatment, if the rupture happens from fracture, is trephining. large the bone opening by the rongeur, pack with one large piece of iodo

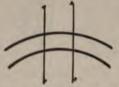


Fig. 454.—Section of outer and inner tables, with two parallel lines (after Agnew).

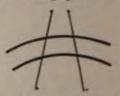


Fig. 455.—Greater yielding of the table than of the outer after the applica violence (after Agnew).

gauze, or catch the rent with hemostatic forceps, leaving them in place three or four days, or apply a lateral ligature or a suture ligature. Eldepressed bone. If during an operation a sinus should be wounded, lateral ligature, a suture ligature, or control hemorrhage by packing.

Intracranial Hemorrhage in the Newborn.—Certainly most of cases of birth palsy seen in children are the result of subdural and subal noid hemorrhage at birth and damage of the cortical motor area. In conditions there is spastic paralysis of the hemiplegic type, or if both I spheres suffered there is plastic diplegia and usually amentia (Cushin "Am. Jour. Med. Sciences," Oct., 1905). It has not been the custo operate for hemorrhage in the newborn; most of the cases do not die, by main for life weakened and paralyzed, or epileptic or idiotic.

main for life weakened and paralyzed, or epileptic or idiotic.

The hemorrhage, in cases of birth palsy, is, as Cushing points out, us

venous and due to "rupture of some of the delicate and poorly supp venous radicles of the cerebral cortex" ("Am. Jour. Med. Sciences," 1905). It may result from traumatism due to bone overlapping or forceps sure during parturition, or may arise during asphyxia after birth. Cushing covered in examining stillborn infants and infants that died soon after that many of them died with cortical hemorrhage. In some the extrations were very large—in fact, completely overlying a cerebral hemisp. In some they were much smaller. In one the clot was in the cerebellar forms.

The vessels usually torn are on one side and are the ussupported ve radicles which enter the longitudinal sinus, hence the leg center of one is the cortical area most apt to be gravely damaged. If the vessels of both

sides are torn, a bilateral cortical lesion results.

Symptoms of Hemorrhage. - In Cushing's masterly paper ("Am. Jour. Med. Sciences," Oct., 1905) the symptoms of recent hemorrhage are set forth. There is the history of a long and difficult labor, forceps perhaps having been used, or a history of postpartum asphyxiation. The fontanelle bulges and perhaps does not pulsate. The fluid obtained by lumbar puracture contains blood-corpuscles. There is usually twitching and, as a rule, convulsions occur. They may occur soon after birth or not for several days. When they occur soon, they may be general; when they occur later, they may be unilateral. Paralysis is rare in the early days after birth. There may be alterations in the circulation and respiration. Pupillary alteration and ocular palsy seldom occur. If the child is not operated upon it may die or it may apparently recover. If it apparently recovers after a considerable hemorrhage, several months may pass before ominous symptorns are recognized. The late manifestations of the disease may be "spastic palsies, or blindness, or deafness, or feeble-mindedness, or, in severe cases, even complete amentia" (Cushing). Epilepsy may be a result.

Treatment.—Osteoplastic craniotomy in the parietal region, on one side or both, according to the unilateral or bilateral nature of the hemorrhage; opening of the dura; washing out and turning out the clot; suturing the dura and closing the scalp without drainage. Cushing reports 4 cases, in one of which operation was done on both sides. He says chloroform should be given and that the parietal bone can be cut with blunt, curved scissors.

Fractures of the skull may be simple, compound, depressed, non-depressed, or punctured. A fracture of the skull may be produced by a bending force, by a bursting force, or by an explosive force (see Gunshot-wounds).

A bending force is usually applied by the forcible impact of a body of small area. It produces a fracture and seldom causes distant injuries. The fracture may be of the inner table only, or of both tables. If both tables are fractured the broken bone is displaced and remains so.

In fracture by bursting, lines of fracture run to distant points from the seat of application of the force. Such an injury is inflicted by the impact of a flat surface of considerable area. In some cases we have a force which first is bending in character, but causes bursting to also occur, because there is no rebound.

Falls of large heavy objects or falls on the head, blows from large flat objects on the head, crushes in railroad accidents, etc., may burst the skull. In

bursting fracture there is often widespread injury.

Fractures are divided into fractures of the *vault*, usually due to direct force, and fractures of the *base*, due to extension of fractures of the vault, to indirect violence (a fall upon the feet, the buttocks, or the vault), to forcing of the condyles of the lower jaw against or through the base, or to foreign bodies breaking through the orbit, vault of the pharynx, the ear, or the roof of the nostrils. *Fracture by contre-coup*, which occurs on the side opposite the point of application of the violence, is very rare. Fractures of the skull are uncommon in early youth, but they are much more frequent in the aged. Usually the entire thickness of the bone is fractured, but either the outer or the inner table (Fig. 456) may be broken alone. In complete fractures the inner table is broken more extensively than is the outer table, because the

inner table is the more brittle, because the force diffuses, and also, as Agnew taught, because the inner table is part of a smaller curve than is the outer table, and violence forces bone-elements together at the outer table, but tears them as under at the inner table (Figs. 454, 455.

Fractures of the Vault.—A fracture of the vault of the skull may be simple and undepressed, or it may be depressed (Figs. 450 and 456), compound, or comminuted. A mere crack may exist in a bone, and if a rent

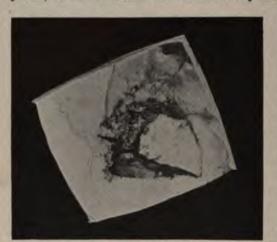


Fig. 456.—Fracture of the vault with extensive depression of the inner table ("American Text-book of Surgery").

exists in the soft parts, a bit of dirt or a hair may be caught in the crack. Fractures of the vault arise from direct force. A fissure may escape recognition, although in some cases percussion gives a "cracked-pot" sound. Any considerable depression can be detected. In a simple fracture occasionally the cerebrospinal fluid collects under the scalp and forms a tumor which pulsates and becomes tense forcible expiration (spurious meningocele, Compound page 705).

fracture can be readily recognized, but do not mistake a suture, a Wormian bone, or a tear in the pericranium for a fracture. A fissured fracture is marked by a dark line of blood which sponging will not remove. Fracture of the inner table alone can only be suspected. The prognosis of fracture of the vault depends upon the extent of brain injury rather than upon the extent of bone injury. Simple fractures unite by bone; compound fractures with loss of bone unite only by fibrous tissue. The dangers may be immediate (hemorrhage, brain injury, and septic inflammation) or be distant (epilepsy, insanity, and persistent headache).

Treatment.—The mortality of fracture of the skull was formerly much greater than at present. Before the days of antisepsis it was 51 per cent. (Harte). Trephining is performed much oftener than was once the custom, and is vastly safer. Out of 26 trephined cases, 3 died (Harte). In any case of fracture of the skull endeavor to bring about reaction before operating, unless the signs of pressure continually increase or the evidences of shock remain unimproved or become graver. A simple fracture without depression and without brain symptoms is treated expectantly (by rest, quiet, low diet, purgation, moderate elevation of and cold to the head, and arterial sedatives). A simple fracture with moderate depression and without cerebral symptoms is treated expectantly, and so also is a simple fracture in which symptoms existed but are abating. Simple fracture with marked depression requires immediate trephining, even when brain symptoms are absent. Some surgeons make an exception in young children, and wait a while before trephining, in the expectation that the expansile brain will lift the depressed but elastic

bone up to the level. Trephining in cases where no symptoms exist, although there is marked depression, often prevents disastrous consequences arising in the future, and is known as "preventive trephining" (Agnew, Keen,

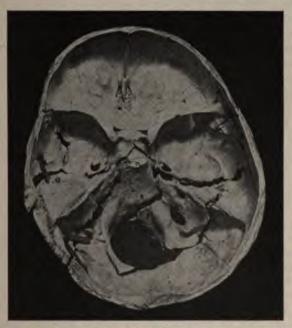


Fig. 457.-Extensive fracture of the base of the skull ("American Text-book of Surgery ").

Horsley, Macewen, von Bergmann, and others). In all compound fractures shave and asepticize the entire scalp, enlarge the incision, and explore the bone. If a fissure exists, it must be asepticized, and if a hair or other foreign body is found in it, in order to effect removal and secure asepsis the outer table of the skull must be cut away with a chisel, the fissure being thus converted into a broad groove. In a compound fracture with much depression trephine, elevate, and irrigate. In any fracture trephine if distinct symptoms exist. In punctured wounds of the brain (punctured fractures) always trephine, open the dura, and disinfect (Keen). In any case of fracture of the vault where trephining has been performed it is wise to open the dura and examine the brain.

Fractures of the Base.—A fracture of the base of the skull may exist in only one of the three fossæ, in two of them, or it may involve all. Fig. 457 shows an extensive fracture of the base of the skull. The middle fossa is oftenest involved. Fracture of the posterior fossa is the most fatal. These fractures may be due to direct volence, to indirect force, and to extension of a fracture of the vault. Extension from the vault is always by the shortest route. Fracture by direct violence may arise from the penetration of the nasal roof, the orbital roof, or the pharyngeal roof by a foreign body. The posterior fossa may suffer from a fracture by direct violence applied to the neck. Fractures by indirect force may arise from blows upon the frontal bone (the orbital portion of the frontal or the cribriform process of the ethmoid breaking), from falls upon the chin (the condyle of the jaw breaking the

middle fossa), or from falls upon the buttocks, the knees, or the feet (fracture occurring in the posterior fossa). The base is very rarely broken by contre-

coup (Treves).

Symptoms.—Fractures of the base of the skull are apt to be compound. solution of continuity in the pharynx, roof of the nares, orbit, or ear permits access of air to the seat of fracture and allows blood and cerebrospinal fluid to flow externally. In fracture of the anterior fossa the fracture may be compound, because of laceration of the mucous membrane of the nares or of the conjunctiva. Blood may run from the nose, its source being the vessels of the mucous membrane or the dura, the fracture being compound. Epistaxi does not prove the fracture to be compound, but only suggests it; but if the epistaxis is prolonged, the probability is greatly increased; and if the flow o blood is succeeded by a flow of cerebrospinal fluid, the diagnosis of compound fracture is positive. Cerebrospinal fluid appears only when the mucous mem brane, the dura, and the arachnoid are each lacerated (Treves). In fracture of the anterior fossa blood is apt to flow into the orbit, producing subcon junctival ecchymosis, and some blood is often swallowed and vomited. In fractures of the middle fossa blood may flow from the ear through a tear in the tympanum, its source being the vessels of the tympanum, the meningea vessels, or a sinus. Blood may flow through the Eustachian tube and comfrom the nose, may be spit up, or may be swallowed and vomited. In some cases a quantity of cerebrospinal fluid flows from the ear, the discharge being increased by expiratory effort and a position which favors gravity. The cerebrospinal fluid must not be confused with either blood-serum or liquor Cotunnii. The cerebrospinal fluid is always present in large amount; the liquor Cotunnii can be present only in minute amount. Blood-serum is highly albuminous; cerebrospinal fluid is a serous fluid of very low specific gravity, never shows more than a trace of albumin, and contains considerable chlorid of sodium and in some instances sugar, which, when present, reacts to Trommer's and to Moore's tests, but does not refract polarized light no ferment with yeast (Keetley, from Collins). Treves states\* that cerebrospina fluid cannot flow from the ear in fractures of the middle fossa-(1) unless the line of fracture crosses the internal meatus; (2) unless the prolongation of the membranes into the meatus is torn; (3) unless a communication exists between the internal ear and tympanum; and (4) unless the drum-membrane is torn Miles, of Edinburgh,† claims that bleeding from the ear followed by a flow of cerebrospinal fluid is not pathognomonic of fracture of the middle foss of the base. He maintains that when the drum is ruptured, we may hav these signs; when bone is not broken, the chief source of the blood being the vessels of the pia and temporo-sphenoidal lobe, the blood and cerebrospina fluid flowing inside the sheath of the auditory nerve, passing into the vestibule through the lamina cribrosa, and from the vestibule into the middle ear finding exits from this space by way of the Eustachian tube and also through the rent in the drum-membrane. Profuse serous discharge may flow from the ear after an injury without fracture when the drum is ruptured, the fluid coming from the cells of the mastoid. It must be understood that fracture of the base may exist when there is no flow of blood or of serous fluid. fracture of the middle fossa is usually compound, made so, even when the

<sup>\*&</sup>quot;Applied Anatomy."
† Edinburgh Med. Jour., Nov., 1895.

drum is not ruptured, by the Eustachian tube, and there is often paralysis of the seventh or eighth nerve or of both of them. In fracture of the posterior fossa there is usually respiratory derangement and blood accumulates beneath the deep fascia and produces discoloration in the line of the posterior auricular artery (Battle's sign), the discoloration first appearing near the tip of the mastoid. The discoloration appears in the line of nerves and vessels which emerge from the deep fascia, the vessels passing through openings and the extravasated blood emerging from the same openings. Fractures of the posterior fossa are apt to be compound through the pharynx, and in such cases the patient spits or vomits blood. Fractures of the posterior fossa are more fatal than fractures in either of the other fossæ because of the adjacency of vital centers. Fractures of the base are apt to be associated with paralysis of cranial nerves. Optic neuritis often arises after the first week. In fractures of the base the temperature is subnormal during the shock, rises to 100° to IOIO, falls again to about normal, and remains normal or subnormal unless there be inflammation or sepsis. Lumbar puncture may obtain bloody fluid. Such a finding means subarachnoid bleeding and indicates fracture. Harte ("Annals of Surgery," Oct., 1901) has collected 46 positive cases of fracture of the base of the skull from the records of the Pennsylvania Hospital; 35.5 per cent, recovered.

Treatment.—In fracture of the base I now always do a subtemporal decompression usually on both sides as Cushing advocates. This is, first of all, exploratory and may disclose a bleeding meningeal artery. After the dura is opened it enables us to evacuate fluid causing pressure and in which bacteria could multiply, and to prevent recurrence of pressure after the wound has been closed. If there is bleeding under the dura the brain should be lifted to let the blood out, and a drain of rubber tissue should be inserted. If there is only brain edema no drain is required.

In addition to performing decompression I always give urotropin, as advised by surgeons in Johns Hopkins. (S. J. Crowe, in "The Johns Hopkins Hospital Bulletin," April, 1909). This drug renders the cerebrospinal fluid bactericidal. Other methods of treatment are secondary to the above. My experience is that this plan saves many cases which would otherwise perish. Until lately the methods were as follows. In treating a compound fracture of the base of the skull collect any serous discharge and analyze it, and disinfect any cavity involved. In fractures of the middle fossa with ruptured drum clean the ear mechanically, wash it out with a stream of warm corrosive sublimate solution of a strength of 1: 2000 (turn the head toward the affected side while washing, so that the mercurial solution will not run down the Eustachian tube), wash with normal salt solution, insufflate iodoform, insert a piece of iodoform gauze, and apply an antiseptic dressing. Several times daily the ear is to be irrigated, and insufflated with iodoform. The nasopharynx must be frequently irrigated with normal salt solution or boric-acid solution, and insufflated with iodoform. The conjunctival sac is frequently irrigated with boric-acid solution. If after a head injury blood accumulates back of the drum, this membrane should be incised to permit of drainage and disinfection. In fractures of both the middle and anterior fossæ and in fractures of the posterior fossa communicating with the pharynx the nasopharynx must always be cleaned. The exact method depends on the choice of the surgeon. We may wash out

these cavities frequently with hot water, next with peroxid of hydrogen, and finally with boric-acid solution, or can simply use normal salt solution. After

washing, insufflate the nasopharynx with iodoform. Repeat the cleansing at regular intervals and also cleanse the conjunctival sac frequently. In some cases drainage has been obtained from the anterior fossa by breaking through the cribriform plate and introducing a tube by way of the nostril (Allis), and from the middle fossa by trephining above and behind the external auditory meatus. In a compound fracture of the orbit disinfect and drain. It may be necessary to trephine the roof of the orbit to secure drainage. In fracture of the



Fig. 458,-Extensively comminuted gunshot-fracture of the skull (after von Bergmann).

posterior fossa examine to see if the fracture is compound, into the

pharynx, and if it is, cleanse with great care the nasopharynx and mouth, as previously directed. In a very extensive fracture of the base, besides use of the methods set forth above, the entire head should be shaved and a plaster-of-Paris cap be applied. A patient with fracture of the base must be put into a quiet and darkened room and be kept upon a low diet, sleep being secured, and the bowels and bladder being attended to. If we are uncertain as to whether a fracture exists or not, keep the patient quiet and in a darkened room and on a low diet. Attend to the bladder, keep the bowels loose, examine the nasopharynx with mirrors and the ear-drum through a speculum, and make a lumbar

Wounds of the brain are produced by violence and by foreign bodies (knives, bullets, etc.). Except when

puncture.



Fig. 459.-Gunshot-fracture of internal table of the skull (after von Bergmann).

due to penetration of a fontanelle in a child or of a parietal foramen in adults, wounds of the brain are accompanied by fracture of the skull. These wounds are very dangerous; foreign bodies (bone, hair, clothing, etc.) are often lodged in the brain, hemorrhage is usually severe, and sepsis is almost inevitable without proper treatment. Such cases are very fatal, though some astonishing recoveries are on record. Figs. 458 and 459 show gunshot-fractures of the skeull.

The symptoms of brain-wounds may be slight and long-deferred or may be immediate and overwhelming; they depend upon the site and extent of the injury. Localizing symptoms may exist, and encephalitis with coma is apt arise. Abscess not unusually follows.

In treating wounds of the brain always shave the entire scalp and examine weapon, if possible, to see if a piece were broken off. Asepticize, enlarge wound, trephine, arrest bleeding, elevate any depression, remove foreign bodies, irrigate the wound, drain with gauze, suture the dura, and dress.

Wounds in War.—When the bullet of a military rifle, fired at very close range, crosses the brain it may blow the skull into fragments, but often it does not, and produces fracture of the skull and wound of the brain. plosive effect" is far less marked on the head of a living man than on the head of a corpse and may even be absent when the range was only 100 yards. At moderate range, at the point of initial contact of the bullet with the skull a fracture is produced, the opening is slightly larger than the bullet, and short fissures commonly radiate from it. Fragments from the internal table are usually displaced and driven into the brain. The wound of exit is more irregular and is apt to exhibit more and longer fissures than the wound of entrance. When a bullet strikes a glancing blow it may fracture the outer table alone; it may produce a "gutter-fracture" (two scalp openings, and "a gutter Ploughed" through both tables of a portion of the skull, as O'Reilly expresses 11), very seldom a fracture of the inner table only, penetration of the skull, and lodgment of the bullet, and perforation of the skull, the bullet passing through the head and emerging. Nearly half the cases are instances of perforating wound.

In all of these injuries there is great shock, but concussion symptoms may be absent. The patient may die at once or almost at once, but if he is alive a few hours after the injury he has still to face the danger of infection and resulting inflammation. The danger depends on the brain injury and the amount of infection and not on the extent of the bone damage. The symptoms vary according to the part of the brain injured and the extent of the damage.

In practically all cases bone fragments are driven into the brain, and as the scalp is a dirty region, the wound is more or less infected.

The mortality from these injuries is very large. In the American Civil War it was 61.2 per cent. In the Franco-Prussian War it was 51.3 per cent. In the Boer War, among the British it was only 33.1 per cent., a very notable improvement. (See Military Surgery, by Surgeon General Robert N. O'Reilly, U. S. A., in "Keen's Surgery," vol. iv.) In the Russo-Japanese War the mortality seems to have been something over 37 per cent.

In estimating mortality those killed outright and those dying before reaching the hospital are not counted. Much brain matter may ooze out from such a wound. Cerebral hernia is common after these injuries, especially if much bone was destroyed by the injury or removed by the surgeon.

Treatment of Wounds in War.—At the first aid station antiseptic dressings are applied. On reaching the field hospital the wound is explored, if time, situation, and military necessities permit. Every wound of this sort is regarded as being complicated by infection and by depression or wide dispersion of bone fragments. The patient is reacted from shock and a flap of scalp is turned down to permit of exploration. Depressed fragments of bone are elevated or removed and loose pieces are removed. Treatment is the same as for wounds from revolver bullets (see below).

Wounds from Revolver Bullets.—The bullet may strike the skull and glance (if fired at an angle) with or without the production of a fracture. A small bullet (No. 22) may strike perpendicularly and fail to enter, sometimes causing a fracture and sometimes not doing so. Even a No. 22 may enter the skull, and I recently removed a bullet of this size which had entered and crossed the skull and lodged beneath the cortex on the opposite side of the brain. A bullet may cause a "gutter-fracture"—may enter the cranium and lodge—or may cause a complete perforation. A revolver bullet is much more apt to lodge than a military bullet.

The wound of entrance is small; the wound of exit is larger. At the wound of entrance the inner table is more extensively fractured than the outer table; at the wound of exit the outer table is more widely broken than the inner table. In these cases there is always great shock and concussion, and concussionsymptoms exist even when the bullet has entered the brain. In moderate concussion the action of the heart is retarded; in severe concussion it is accelerated (page 797). A bullet may be lodged within the cranium when merely a fracture without a bullet-hole can be detected. In these cases the bullet produced a fracture and entered the cranium, and then the depressed bone flew back into place (v. Bergmann). In such cases, if complete perioration occurs, the one existing opening is the opening of exit. A bullet may lodge in the bone, between the dura and the bone, between the dura and brain, in the brain, between the dura and bone of the opposite side, or in the bone of the opposite side, in the nasal fossa, maxillary antrum, or orbit. Always examine the side of the head opposite to the wound of entrance to determine if there is any bulging or fracture. A bullet may pass across the brain and be deflected from the inner surface of the skull. Ruth does not believe the bullet can rebound from the opposite wall.\* If certain regions are injured localizing symptoms may arise. Much brain matter may ooze out from the wound. Sometimes this causes great impairment of function, sometimes little or none. The secondary symptoms of gunshot-wounds of the head are varied and uncertain, and may not be observed at all before death. Fowler wisely points out that a patient with a gunshot-wound of the head may have also received other injuries, and the other injuries may be in part, at least, responsible for cerebral symptoms.

Treatment of Wounds from Revolver Bullets.—Endeavor to bring about reaction (see Concussion). In severe cases apply heat to the head and make artificial respiration. It will sometimes be necessary to operate while artificial respiration is being made. In treating gunshot-wounds of the head shave and asepticize the whole scalp, disinfect the entire track of the ball, and arrest hemorrhage at the wounds of entrance and exit, using the rongeur to expose the bleeding points if the bullet be large, employing the trephine if it be

<sup>\*</sup> See the instructive article by Fowler, in Annals of Surgery, Nov., 1895.

small. If the bullet has emerged and has been picked up, examine it to see if it is entire. The bullet, if retained, is to be sought for. The x-rays are invaluable in locating the missile. Place the head in such a position that the track of the ball will be vertical, then introduce Fluhrer's aluminum probe or Senn's probe, and let it find its way by gravity. The probe may find the ball near the wound of entrance, in which case extract the ball with forceps; or the probe may find the ball near the opposite side of the head, in which case make a counter-opening through the bone at a point the probe would touch if it were pushed entirely across. Take a new and clean rubber catheter (No. o, French), insert a stylet, and carry the catheter through the wound (Keen). Knowing the depth of the ball, search for it around the catheter-tube as an axis, and when found, extract it. After extraction drain the wound by means of a tube. When a counter-opening exists, drain through and through. If the ball cannot be detected, drain by a tube carried to the depths of the wound. After dressing always place the head in a position favorable to drainage. Fluhrer tells us that when a counter-opening fails to disclose the bullet, use the new opening as a doorway through which to search for the ball. He believes the bullet is not unusually deflected. The angle of deflection is somewhat greater than the angle of incidence, and the bullet is apt to fall a little toward the base. Splinters of bone are often driven into the brain by a bullet, and these should be removed whether the ball is found or not. Several varieties of probes have been commended. Fluhrer uses a large-sized aluminum probe. Senn uses



Fig. 460.—Senn's bullet-probe.

an instrument shaped like the Nélaton probe, but of the same diameter as the bullet (Fig. 460). (Of course, the porcelain probe will not show a black mark from contact with a hard-jacketed bullet.) Fowler uses a graduated pressure probe; so long as the pressure is within the limits of the spring, as shown by the scale, the probe is in the bullet-track. Girdner's telephonic probe is a valuable aid to diagnosis. Bullets are now located by the Röntgen mays. There can be no doubt that many gunshot-wounds have been recovered from without operation, and it is beyond question that many deaths follow operation (about 33\frac{1}{3} per cent., according to Hahn). Von Bergmann is so impressed with these facts that he does not operate when cerebral symptoms are absent.

Prolapse of the Brain and Hernia of the Brain.—In a compound fracture, especially a gunshot-fracture, with torn dura and pia, brain-matter may emerge from the wound. In fracture of the base brain-matter may enter the orbit, the nose, or the ear. A flow of brain-matter may continue from a wound for many hours. A week or more after an injury a portion of the brain may protrude or prolapse. To this condition the term prolapse should be applied. In many instances the protrusion is covered with pia, but if the pia were torn or cut, it will not be a covering. This protrusion emerges from the opening in the skull, mounts up, growing larger and larger, until it may

become the size of a fist. It usually pulsates. When bare it is soft, lobulated, of a dirty white color, pulsating, painless to the touch, often bleeding,



Fig. 461.—Hernia cerebri under scalp after operation for brain tumor (W. W. Keen).

and sometimes discharging cerebrospinal fluid. Death may soon follow such protrusion, but the protruding mass may become necrotic and be sloughed off, a granulating surface remaining, which heals. Hernia cerebri (Fig. 461) sometimes follows operations upon the brain or injuries of the skull and dura, when large pieces of bone have been removed or when the dura has been widely cut or torn and has not been carefully sutured. The condition is due to increased cerebral pressure. Hernia of the brain is protrusion through the dura but not through the scalp, the scalp wound being healed above the protrusion. In a decompression operation we deliberately create a hernia of the brain. Prolapse of the brain is treated

by antiseptic dressings and perhaps by craniotomy to relieve pressure. Skin-grafting benefits some cases. Pressure is dangerous. Excision by the knife or cautery seldom does any good. Hernia in some cases can be treated by repeated lumbar punctures, in some others by craniotomy

of the opposite side of the skull.

Fungus Cerebri (Fig. 462).-When the brain is exposed, a granuloma may grow from the neuroglia and fungate through the skull. This condition is fungus cerebri and is not composed of brain-matter. It is due to infection of the brain, and is most frequent when a bit of bone or some other foreign body is retained. A fungus is soft to the touch, is livid in hue, bleeds easily,



Fig. 462,-Fungus cerebri (W. W. Keen).

frequently contains multiple foci of suppuration, and pulsates. It often attains the size of a small orange. It is treated by removing the granulations and any foreign body, and applying, with moderate pressure, aseptic dressing soaked in alcohol. After healing, a depression marks the site of the fungus.

Traumatic inflammation of the brain and its membranes is divided into encephalitis or cerebritis, inflammation of the cerebrum; cerebellium; inflammation of the meninges; arachnitis, inflammation of the arachnoid; pachymeningitis, inflammation of the dura; and leptomeningitis, inflammation of the arachnoid

and pia.

Pachymeningitis Externa.—Inflammation of the external layer of the dura is called pachymeningitis externa. It may arise from tumor, caries, necrosis, middle-ear disease, sunstroke, or traumatism. Syphilis is a not unusual cause. The other membranes may become involved. Suppuration may arise, having extended by contiguity from neighboring parts. The symptoms of pachymeningitis externa are uncertain. They resemble often those of leptomeningitis (page 818). Pressure-symptoms may arise. Headache is always present. Paralysis may or may not exist. If pus forms, the ordinary constitutional symptoms of suppuration are evident (high temperature and sweats), not the symptoms of abscess in the brain. In a severe case the other membranes become involved.

The treatment consists in removing the cause (carious bone, pus, middleear disease). In pachymeningitis from traumatism it is sometimes advisable to trephine in order to drain inflammatory products; in a case with localizing symptoms always trephine; in an ordinary case, without pus and with no evidences of traumatism, use wet cups back of the mastoid processes, apply an ice-bag to the head, and purge by means of calomel. Administer iodid of potassium in most cases. If sunstroke is the cause, treat according to ordi-

nary medical rules.

Pachymeningitis Interna.—This term means inflammation of the inner layer of the dura. Inflammation may extend from the pia, or from the outer layer of the dura. The disease is most often met with in infants and in the chronic insane, but may occur in those not insane in late middle age or beginning old age. The form known as hematoma of the dura mater, or pachymeningitis interna hamorrhagica, may arise during infectious disease (typhoid fever and rheumatism), in persons of the hemorrhagic diathesis, in diseases causing atrophy of the brain, in chronic diseases of the heart and kidneys, and in syphilitics. Among the exciting causes are traumatism, inflammation in adjacent parts, and, especially, the abuse of alcohol. In this disease blood is extravasated on the inner surface of the dura. Many observers do not class hemorrhagic pachymeningitis as inflammation, but regard the hemorrhage as primary.

The symptoms of internal pachymeningitis are very chronic, come on gradually, are not characteristic, and may be absent. They consist usually of mental irritability or excitement, followed perhaps by hebetude and persistent headache; and apoplectiform attacks, with contraction of the pupil, slow pulse, and vomiting; there may also be muscular rigidity and spasm of the extremities. Choked disc is not infrequent; localizing symptoms may be made

out, and coma is apt to arise. Cranial nerves are seldom affected.

The treatment is operation. This is unpromising, but Munro saved

1 case out of 5 ("Chicago Med. Recorder," Dec., 1902).

Acute leptomeningitis is a purulent inflammation of the soft membranes of the brain. The pathological changes can be noted in the pia and in the brain-substance. The brain is edematous, the pia purulent, the convolutions are flattened, the ventricles are distended with fluid, and hemorrhages occur into the brain-substance. Pus may be localized upon the pia, but it is usually diffused over one hemisphere or over both. Various organisms may be found, especially streptococci, staphylococci, and diplococci. In some cases we find the bacillus pyocyaneus or the bacillus pyocyaneus fœtidus, which is identical with the colon bacillus and with the bacillus meningitis purulenta (Park). Saprophytic organisms are occasionally present. This disease may be acute or chronic, and a severe case is spoken of as encephalitis. Secondary leptomeningitis is apt to affect the convexity; primary leptomen-

ingitis is apt to affect the base.

The causes of leptomeningitis are epidemic cerebrospinal fever, tuberculosis, acute general disease (pneumonia, typhoid, erysipelas, and rheumatism), bone-diseases, traumatisms, middle-ear disease, syphilis, and sunstroke. The tissues of the pia and the cerebrospinal fluid contain diplococci identical with pneumococci. Infection may take place by various avenues. It may pass from the nose by way of the Eustachian tube to the ear, or from the nose to the frontal sinus or ethmoid sinuses (Hirt), and from these situations to the brain. It may pass from the middle ear or mastoid to the membranes of the brain. In fractures at the base the organisms enter by way of the pharynx and the Eustachian tube, or the ear. The symptoms of acute leptomeningitis are violent headache persisting during delirium, flushing of the face, rigidity of the neck, cerebral vomiting, a slow pulse, elevated temperature, photophobia, contraction of the pupils, intolerance of sound, hyperesthesia of the skin and muscles, and delirium passing into stupor and coma. A chill or a succession of chills may occur. Choked disc, strabismus, and nystagmus are not unusual. Convulsions or paralyses may occur. Death is the rule within one week. The treatment usually consists of the administration of urotropin (this drug rapidly enters the cerebrospinal fluid, see page 811); purgation with calomel; cold to the head; warm baths with cold affusions to the head; iodid of potassium, bromid of potassium, or morphin for vomiting and headache. Lumbar puncture is usually performed, but for diagnostic rather than therapeutic reasons. A patient in this condition should be trephined in order to relieve pressure and to give exit to inflammatory products. It gives some hope of recovery, and the usually adopted medical treatment is practically useless. After trephining, the administration of urotropin should be continued. Should the patient recover, he must be guarded for a long time from physical exertion, mental excitement, worry, irritation, constipation, and insomnia.

Chronic Leptomeningitis (or Chronic Encephalitis).—The causes of chronic leptomeningitis are the same as those of the acute form. If traumatism is the cause, the inflammation arises at a later period than it would in acute encephalitis. The symptoms of concussion follow a head-injury. Days, or even weeks, after the accident, a series of symptoms occur—namely: localized pain at the seat of injury, often accentuated by tapping; listlessness; irritability; apathy regarding business affairs and home obligations, or profound depression and hypochondria with inability to attend to business. Choked disc may exist. In any case acute encephalitis may arise, with or without a chill. The treatment of this disease is symptomatic unless local symptoms exist. Always operate if localizing symptoms are found. Intense local pain justifies trephining.

Tuberculous Meningitis (Acute Hydrocephalus; Water on the Brain).—This inflammatory condition is due to the bacilli of tuberculosis. In a child affected with tuberculous meningitis there is often a record of a fall, the injury acting as an exciting cause by establishing an area of least resistance. Prodromal symptoms are common (restlessness, irritability, amorexia, change of character). The disease begins with a convulsion or with headache, fever, and vomiting, the child cries out from pain (the hydrencephalic cry), and the bowels are constipated. The pulse is rapid in the beginning, but later becomes slow and irregular. The pupils are contracted, there is muscular twitching, and the sleep is impaired. The temperature is about 103°. In the second period of the disease the vomiting ceases, constipation becomes more marked, the belly retracts, headache is not so violent, and the patient lies in a soporose condition interspersed with episodes of delirium. In this stage the pupils dilate and are often unequal, the head is retracted, convulsions occur or limited rigidity is noted, the respirations are sighing, and if a finger-nail is drawn along the skin, a red line develops (the tache cerebrale, due to vasomotor paresis). Squint and consequent double vision are usual. In the last stage coma becomes absolute and general convulsions or limited spasms are apt to occur. Optic neuritis exists, and the child passes to death along a road identical with that of typhoid collapse. In some cases the examination of cerebrospinal fluid withdrawn by lumbar puncture throws light upon the diagnosis. In children the base of the brain is usually involved, and the disease is apt to last from two to four weeks; in adults the convexity is usually involved, and death is apt to occur in a few days.

The treatment is like that for traumatic meningitis. Operation seldom offers any chance of improvement, and never does unless the process is limited in area and confined to the convexity. Lumbar puncture is usually performed but for diagnostic rather than for therapeutic reasons.

Abscess of the brain is a localized collection of pus. The organisms found are noted upon page 818 (Acute Leptomeningitis). The causes are suppurative otitis media (in half of all the cases), fracture of the skull, osteomyelitis of the cranial bones, abscess of the lung, gangrene of the lung, empyema, and concussion or wound of the brain, and general diseases. As Ballance points out, abscess of the brain complicating head injury is not really an abscess of the brain unless the wounding material entered into the brain substance. In most cases the abscess is "a local meningeal suppuration with participation of the adjacent brain cortex, a meningocortical abscess rather than a brain abscess proper" ("Some Points in the Surgery of the Brain," by Chas. A. Ballance). General infections may cause abscess (pyemia, tuberculosis, and specific fevers). A tuberculous mass may caseate (tuberculous abscess). The abscess may be between the dura and skull (extradural), adhesions forming and preventing a general leptomeningitis, between the dura and brain (subdural), or in the brain-substance (cerebral or cerebellar). Leptomeningitis may arise because no adhesions are created, because septic clots form in veins or sinuses, or because infected blood regurgitates into the sinuses (Park). A traumatic abscess is generally beneath the area to which the traumatism was applied, but it may be on the opposite side. Source of infection may be the nose, the orbit, or the middle ear (page 820). Roswell Park says infection may pass along blood-vessels, lymph-vessels, nerve-sheaths, or the prolongations of the membranes which extend outside of the skull. An acute inflammation of the middle ear rarely causes abscess, because an acute inflammation in sound tissue causes the formation of granulation tissue, which acts as a barrier to infection. Chronic inflammation of the middle ear is the most frequent cause of abscess. Park tells us that if the roof of the tympanum is involved, it may perforate and abscess of the middle fossa may form; if the tympanum is perforated toward the mastoid antrum, the abscess arises in the temporosphenoidal lobe; if the perforation is toward the sigmoid groove, the abscess forms in the cerebellum.\*

Chronic bone disease is seldom followed by spreading meningitis, often by abscess. When infection reaches the brain by direct extension from a suppurating bone it must pass through the membranes, but it is usually limited by adhesions. The cortex is very vascular, and strongly resists infection and is seldom extensively destroyed, but the white matter is far less resistant and abscess tends to form in it (Ballance, Ibid.). In some cases of abscess of the temporal lobe following ear disease the cortex seems normal, in others the membranes and cortex are fused over a narrow area which constitutes the stalk of an abscess in the white substance of the lobe. This is the "mushroom abscess" of Ballance. An abscess may increase rapidly in size and finally break into a ventricle or through the cortex. It may become encapsuled and latent. A slow-growing abscess may push aside nerve-fibers as does an encapsulated tumor, but a rapidly growing abscess destroys them.

In the cerebrum multiple abscesses, except in cases of general infection, are seldom seen. In the cerebellum they are not uncommon. One or several abscesses may arise from a primary one. If they are adjacent to the primary one they are called satellite abscesses and tend to break into the older purulent

area.

Ballance, in considering the onset of abscess, adopts the views as to the five types set forth by Brissaud and Souques. These types are as follows ("Some Points on the Surgery of the Brain," by Chas. H. Ballance):

(1) A subacute evolution. In this there is a febrile onset, like the onset of a specific fever, with headache, vomiting, and elevated temperature. After a few days there comes a remission, the period of delusive calm. In this period symptoms are absent or trivial. Though there may be progressive emaciation, there is no elevation of temperature in this period.

Suddenly convulsions occur which are followed by coma, or coma arises without antecedent convulsions. The patient may die in coma or the coma may pass away, "the symptoms indicating a local brain lesion" (Ballance, Ibid.). In this stage elevated temperature may appear again.

- (2) Evolution with violent general infection, the symptoms of abscess being merged and usually lost in the symptoms of general infection.
- (3) Evolution with complete latency. The patient presents no symptoms until a few hours before death or he may die suddenly without a symptom having been observed. In this connection Ballance speaks of the difference between "symptoms not noticed and symptoms not present" (Ibid.).
- (4) Only when symptoms were not present does he use the term "complete latency" to indicate the condition. Ransohoff has reported the case of a boy in whom an abscess in the frontal lobe was latent for three years and another case in a man due to gunshot injury, which was latent for four and a half

<sup>\*</sup> Park, in Chicago Med. Record, Feb., 1895.

years and in which nearly ten years elapsed between the injury and death (\*\* Annals of Surgery," July, 1909).

(5) Onset not to be distinguished from a brain tumor.

(6) Onset with headache and fever, or with mental excitement. Then the patient appears to get completely well and remains so for weeks, for months, or for a year, or more. This condition may occur in abscess secondary to influenza (Ibid.).

Symptoms of Abscess of the Cerebral Substance or of the Cerebel-The symptoms due to pus-formation are as follows: There is an in it ial rise of temperature, but (except in extradural abscess) the temperature may quickly become normal or even subnormal. Subnormal temperature is not nearly so common as is usually supposed. It has been present in about one-half of the cases I have seen. Toward the end of the case the term perature may rise and the fever becomes linked with delirium. Surface elevation of temperature over the seat of the abscess is occasionally observed. A chill may occur, but seldom does. Anorexia and vomiting are present. Urinary chlorids are diminished and the phosphates are increased (Somerville). Certain symptoms are due to pressure: Headache begins (which at first is general, then local, and grows worse later in the case, and exists even in delirium; this fact distinguishes it from the headache of fever, which ceases in delirium); pulse is very slow; respiration tends to the Cheyne-Stokes type; drowsiness lapses into stupor and stupor passes into coma; paralysis of the sphincters takes place; convulsions are common; sensation is rarely impaired; and paralysis of the basal nerves may occur (third and sixth especially). The pupil on the same side as the abscess is sometimes dilated and fixed. Choked disc is not invariably found. It may be more marked on the same side as the abscess. Localizing symptoms, spasmodic and paralytic, depend upon the center which is irritated or destroyed. In cerebellar abscess there are vertigo, vomiting, occipital headache, rigidity of the post-cervical muscles, and incoordination, but choked disk may be present or absent.

Meningitis arises soon after an accident; an abscess, more than a week, and often many weeks, after an accident. Meningitis presents high temperature and the general symptoms before outlined. Mastoid disease may occasion cerebral symptoms without abscess, or it may cause abscess. In sinusthrombosis there is septic temperature, the veins of the face and neck are enlarged, and a clot can usually be felt in the jugular. A tumor grows slowly, usually presents almost from the start localizing symptoms, and double choked disc is frequently present. In tumor the temperature is apt to be normal.

Treatment.—If abscess is due to ear disease with implication of the mastoid cells, at once open and clean out the mastoid (Fig. 476), and after this proceed to trephine the skull in order to reach the abscess. In any case, if symptoms of abscess exist, trephine the skull at once. If localizing symptoms are present, open over the suspected region. If localizing symptoms are not present and the cause is ear disease, trephine at Barker's point (Fig. 476). If no pus is found between the bone and dura, open the membrane. When the dura is opened, if the abscess is subdural, pus will be evacuated; if the abscess is in the brain-substance, the brain will bulge very much and will not be seen to pulsate. A grooved director is plunged into the brain, in the direction of the abscess, for two or two and a half inches (Keen). If pus is not found, withdraw the director and introduce it at another point. When pus

is discovered, incise the brain with a knife, enlarge the opening by inserting aclosed pair of forceps and withdrawing the instrument with the blades open. Scrape away the granulation tissue lining the abscess-cavity, irrigate with hot salt solution, and introduce a rubber drainage-tube and suture it to the scalp; stitch the dura, but leave an ample opening for the tube; bring the tube out through a button-hole in the scalp, and after the first two days pull the tube out a little every day and cut off a piece. If the first trephining does not find pus, trephine again at another point. In cerebellar abscess make a flap with the base up, and trephine or gouge away the bone just below the line of

the lateral sinus. Puncture the brain as for cerebral abscess.

Brain Disease from Suppurative Ear Disease.—Chronic disease of the middle ear is apt to destroy the bone between the tympanum and the middle fossa of the skull, and thus produce meningitis, thrombosis of the petrosal or lateral sinuses, abscess of the temporo-sphenoidal lobe or of the cerebellum, or extradural abscess. Chronic otitis media also induces inflammation or suppuration of the mastoid cells (empyema of the mastoid). Pus in the mastoid may discharge itself into the middle ear, and from this point into the external auditory canal, through a perforation in the drummembrane (especially in acute cases). In some cases the pus becomes blocked up within the mastoid process. Pus in the mastoid may after a time break into the cavity of the cranium or into the lateral sinus, or may find its way externally and open into the sheaths of muscles arising from the mastoid. It not unusually opens into the sheath of the digastric muscle (Bezold's abscess). These facts teach the surgeon that chronic ear disease should never be neglected, but should, if possible, receive the closest attention of the specialist. If no perforation exists in the drum, the surgeon must make one. In ordinary cases cleanliness and antisepsis are sufficient, the ear being syringed every day with a warm 2 per cent. solution of common salt. If only a small drum-perforation exists, to drops of pure alcohol or of corrosive sublimate solution (1:5000) are dropped into the ear daily; but if a large drum-perforation exists, boric acid and iodoform (7 to 1) are insufflated. Never inject alum. A strong silver solution is not safe; if it is used, wash the ear out afterward with warm salt water. If granulations or polypi exist, they must be removed. Some cases require the removal of the drum-membrane and the ossicles of the ear. Many cases of mastoid necrosis are due to tuberculosis. If headache, vomiting, and mastoid tenderness exist, open the mastoid (see page 848), in order to prevent abscess of the brain. In acute otitis media it is very rarely necessary to open the mastoid. The middle ear is on a lower level than the antrum of the mastoid, and in most acute cases both the middle ear and mastoid cells drain safely through a drum-perforation. Because a man has chronic otitis media it is by no means always necessary to trephine the mastoid. In many cases removal of the ossicles and drum-membrane effects a cure. In chronic otitis media, even if the mastoid is trephined, the ossicles and membrane ought to be removed.

Cerebral abscess from ear disease is almost always in the temporosphenoidal lobe, but may arise in the cerebellum. The symptoms are a transient rise of temperature, followed in many cases by a normal or subnormal temperature; vomiting; mastoid, frontal, and temporal pain. The mind is dull, and stupor arises which passes into coma; the bowels are constipated; choked disc may be present; and convulsions or spasms or paralyses may exist.

Trephine and clean out the mastoid, and asepticize (see Operations upon the Skull and Brain). Also trephine at Barker's point, one and one-fourth inches behind, and the same distance above, the middle of the external auditory meatus, open the dura, and seek for pus. If pus is not found, open the cerebellum.

Extradural Abscess.—The eye-symptoms and pain are the same in this as in cerebral or subdural abscess, but the temperature is different, rising to 103° or 104° F. There is often considerable tenderness above and behind the mastoid. In extradural abscess following disease of the middle ar trephine and clean out the mastoid; follow up a bone-sinus to the abscess, rongeur away the bone, being careful to avoid injuring the lateral sinus; curet, irrigate, and drain.

Infective Sinus-thrombosis.—Any sinus may be attacked. The disease may result from scarlet fever, smallpox, diphtheria, influenza, typhoid, or any acute suppuration. In erysipelas of the scalp, septic clots may form the veins which pass through the bone and reach the longitudinal sinus. Infective thrombosis of the superior longitudinal sinus is thus produced.

In carbuncle of the lip and orbital suppuration the cavernous sinus may become involved.

In caries of the basilar portion of the occipital bone the circular sinus or the cavernous sinus may suffer. In caries of the petrous portion of the temporal bone, and in suppuration of the middle ear and mastoid process, infective thrombosis of the lateral sinus may occur.

In any case the symptoms are those of pyemia. The lateral sinus is the one most frequently attacked. In infective thrombosis of the lateral sinus there is usually a history of an old discharge from the ear.

Injective thrombosis of the lateral sinus may result from a specific fever, but is usually due to chronic suppuration of the middle ear associated in most cases with carious bone and pus in the mastoid process. Thrombosis of the lateral sinus occasionally follows an operation upon a suppurating mastoid, or develops in an individual who suffers from middle-ear disease who has been struck upon the head, who has had the ear syringed with force, or who has had injected a corrosive or very irritant fluid. Tuberculous bone disease is an occasional cause.

Symptoms.—In most cases there is a history of chronic ear disease. In children the symptoms are more acute than in adults. In any case the symptoms may rapidly become violent. In some cases there are preliminary symptoms of extradural abscess, pus being lodged in the groove of the sinus. It has been pointed out that pus in the jugular foramen may make pressure upon the pneumogastric, spinal accessory, and glossopharyngeal nerves, producing aphonia, hoarseness, dyspnea, dysphagia, and slow pulse (Geo. F. Cott\*). Marked headache ushers in sinus-thrombosis. The pain is apt to be localized about the ear and mastoid process, but may become general. There is usually tenderness of the mastoid. There is high fever from the start, but when the clot begins to soften and break down, hard rigors develop and the temperature fluctuates violently. The temperature varies each day between subnormal and 106° to 107°. A chill may occur once or even twice a day, and it lasts from ten to twenty minutes. The pulse is soft and usually rapid. The patient is nauseated, labors under vertigo, is very restless,

is sometimes delirious, may become dull and stupid, and the muscles of the neck are stiff. Tenderness and marked edema are detected over the mastoid. and the veins of the neck and mastoid region may be enlarged. When the clot extends into the jugular vein there is pain on moving the head and on swallowing, the cervical glands are swollen, and a clot may be felt in the neck. Choked disc exists in about half of all cases. There is often a profuse discharge of pus from the ear, but in some cases the discharge is found to have abated or ceased. Exophthalmos and swelling of the eyelids point to involvement of the cavernous sinus in the process. In early cases there is thrombosis of the lateral sinus alone, or of the lateral sinus and jugular vein. The internal jugular vein may be felt as a cord in the neck. In advanced cases other sinuses become involved (superior petrosal, inferior petrosal, both cavernous, the lateral sinus of the opposite side, the ophthalmic veins, and the torcular Herophili). A patient with sinus-thrombosis is in great danger of developing pulmonary metastasis and septic meningitis (Jansen). Septic meningitis is accompanied by abscess about the sinus. Infective sinus-thrombosis is a very fatal disease and usually runs its course in from seven to ten days, but occasionally lasts for weeks. It is a form of pyemia, and death arises from the causes which have been referred to in discussing that disease.

Infective thrombosis of the cavernous sinus occurs when an infected clot comes from another sinus, from disease of the nasal sinuses, from orbital infection, or from a pyogenic process of the face or lids. It causes pain and the general symptoms of pyemia and also edema of the lids, chemosis, and an extreme degree of exophthalmos. Choked disk may exist. Vision may be normal or impaired. The condition almost invariably spreads to the other eye along the circular sinus.

Injective thrombosis of the petrosal sinus produces pyemic symptoms but

no characteristic signs.

The prognosis largely depends upon early recognition. The surgeon should, whenever it is possible, open a mastoid before sinus-thrombosis arises, and should evacuate an abscess about the sinus before a clot forms in the venous channel, or at least before that clot becomes septic (Jansen).

Treatment.—In 1880 Zaufal proposed the operation now practised, and Horsley first did it in 1886. (See article by Geo. F. Cott, in "American Medicine," April 19, 1902.) Infective thrombosis of the lateral sinus is treated as follows: Open and clean out the mastoid, and expose the sinus by the use of the chisel or rongeur (Fig. 476). Follow M. Ballance's advice and expose the sinus from the bulb to the torcular. The jugular vein should now be exposed at the level of the cricoid cartilage and ligated below any clot which may exist. This is done to prevent propagation of an infected clot and diffusion of sepsis. Even if a clot does not exist in the jugular, the vein should be tied in two places and divided, because the sinus may contain infected clot or putrid material even when the vein as yet does not. According to Ballance, the portion of the vein above the point at which it was divided should be extirpated. Some surgeons after ligating the jugular do not excise it, but if it contains or comes to contain a septic clot, incise the vein up to the base of the skull and pack the wound. After attacking the vein open the sinus, and if a clot is found to exist, cut away the wall of the sinus. Introduce a small spoon into the lumen and carry it toward the torcular Herophili, and scrape away the clot until blood flows. Arrest hemorrhage by plugging a piece of iodoform gauze into the wound and toward the torcular. Jansen opposes removing the entire clot toward the jugular, and does not tie the jugular, believing that to do so increases the danger of thrombosis of the inferior petrosal and cavernous sinuses. He simply removes the soft clot, but does not disturb the solid clot toward the heart. Most surgeons differ from him. Surgeons are of the opinion that it is futile to do any operation if pulmonary metastasis has taken place. In a recent case of the author's in the Jefferson Medical College Hospital the patient recovered after operation in spite of the fact that endocarditis had developed.

Until recently it was thought that the lateral sinus was the only sinus which should be attacked surgically, but in one case Knapp, of New York, requested Hartley to remove from the cavernous sinus a clot which was causing blindness and was due to sarcoma. The operation was successfully executed by Hartley, the incision being the same as is employed to reach a Gasserian ganglion in the Hartley operation. This patient lived several months. Dwight operated upon another case by incision of the sinus (E. W. Dwight and H. H. Germain, "Boston Med. and Surg. Jour.," May 1, 1902). Some surgeons advise removal of the eyeball and curetment of the sinus.

Intracranial Tumors.—An encephalic tumor may originate within the skull. It may have arisen from an external growth invading the cranial cavity, or may be metastatic. A tumor that arises within the cranium may take origin from the periosteum, from one of the membranes of the brain, from the vessels, from the neuroglia, or from the brain-substance.

No region of the body is so liable to tumors as the brain. During the course of a number of years the autopsies of the Munich Pathological Institute are stated by Bollinger to have shown one tumor of the brain in every 85 autopsies. Hale White's experience is that such tumors are even more common than this, and he estimates them at one in every 50 autopsies.

In endeavoring to determine the causes of intracranial tumors we must accredit heredity with considerable influence in tuberculoma, and possibly with some force in sarcoma and carcinoma. Tumors of the brain are decidedly more common in males than in females, probably because of the greater male liability to injury, syphilis, and alcoholism.

The majority of cases of tumor of the brain occur between the ages of twenty-five and fifty. Children are particularly prone to suffer from glioma and from tuberculous growths. In aged persons a tumor of the brain very rarely develops. In 100 cases of brain-tumor collected by Hale White only 2 were aged seventy or over. In 100 cases collected by Mills and Lloyd only 1 was over seventy.

Injury may be responsible for the development of sarcoma, of fibroma, and possibly of other forms; in fact, a syphiloma may arise in a syphilitic person at the seat of an injury.

We use the term intracranial or encephalic tumor not only to include true neoplasms, but also to designate growths of parasitic, syphilitic, or tuberculous origin. It is of importance to attempt to make a diagnosis as to the form of tumor that is present, and this may be possible on account of the fact that in many cases the form affects the symptoms. A useful class-

ification of these growths has been made by Knapp, and is as follows: (1) The infective granulomata, including tuberculous growths, gummata, and actinomycotic areas; (2) connective-tissue growths; (3) epithelial growths; (4) aneurysms. The most common of all these tumors is undoubtedly that due to tubercle. In fact, Gowers estimates that if we exclude syphiloma, tubercle is responsible for one-half of the cases, and glioma and sarcoma together for one-third.

Tuberculous Tumors (Tuberculous Gummata; Tuberculomata).—Tuberculous tumors are the most common form met with. They are at least four times as common in children as in adults. They may be single, especially in adults, but are often multiple, especially in children; and multiple growths may be very wide-spread. According to Allan Starr, these growths are most common in the cerebral axis (especially in the basal ganglia), next in the cerebellum, next in the cerebral cortex, and are least common in the centrum ovale. A tuberculous tumor usually arises in the pia mater, particularly in an arterial distribution, but may begin in a ventricle, or even in the brain-substance. Some of these growths are distinctly subcortical. The tubercle bacilli responsible for the condition are carried by the blood. A large tuberculous tumor is due to the coalescence of many foci. It undergoes caseation in the center, and is surrounded by a zone of softened or sclerotic brain-substance. Tuberculous meningitis is present in two-thirds or three-fourths of the cases of tuberculoma.

Gummatous Tumors (Syphilomata).—We find a single gumma, but, far more often, syphilitic growths are multiple. Such a growth may be round, or may be irregular in outline; in fact, the outline is frequently blurred and indistinct. Some of these growths are soft, and some, which contain a quantity of connective tissue, are hard. A syphiloma usually arises from the membranes, and, hence, is generally on the surface of the brain; and the membranes in the region of the growth usually show distinct inflammation.

Actinomycosis.—This is a very rare condition, in which the mass may remain solid like a tumor, but is far more apt to break down into an actinomycotic abscess.

Sarcomata.—Injury seems to play a considerable part in the production of intracranial sarcoma. Any variety of sarcoma may arise. As a rule, at least in the beginning, the growth is single; but it may be multiple, or may become so. The majority of sarcomata arise from the membranes or from the periosteum, but some cases take origin from beneath the cortex. Early in their progress these growths may be encapsulated, but some of them, from the very start, are infiltrating; and even those that were at first encapsulated later infiltrate. Endothelioma is sometimes met with. What is called angioma of the brain is, in reality, angiosarcoma. A psammoma is usually sarcomatous.

Gliomata.—A glioma is a growth so ill defined and so slightly differentiated in appearance from the brain-substance that it may easily be overlooked in an exploratory operation. It arises much more frequently from the white than from the gray matter, and develops from the neuroglia of the cerebrum, of the cerebellum, of the pons, or of the medulla oblongata. A glioma may be soft or may be hard; and soft gliomata are probably, in reality, sarcomata. Hemorrhage is very apt to occur in these growths.

Fibromata.—Intracranial fibroma is a rare growth. It is of firm consistence, is encapsulated, and may grow to a large size. Such growths can be readily enucleated. Injury seems occasionally to be responsible for their formation.

Osteomata.—Osteophytic growths not uncommonly take origin from the inner surface of the skull, but the osteomata arising in the dura or in the brain-substance are rare. Such growths, however, occasionally occur.

Cholesteatomata.—These tumors are fibrous growths covered with endothe lium and containing layers of cholesterin. They are particularly apt to arise in the pia mater, but may begin in either of the other membranes or in the brain-substance. A cholesteatoma is commonly called a pearl tumor.

Enchondromata and true neuromata are rare, and lipomata are exceedingly

Adenomata.—An adenoma occasionally springs from the conarium, or the pituitary body.

Carcinomata.—Primary intracerebral carcinoma is rare, but does occur. Secondary carcinoma is more common, and may follow cancer of any part of the body, although it is most apt to follow cancerous growths about the face and neck. A primary growth may begin in the meninges or in the lining of the ventricle. Intracerebral carcinomata may be single or multiple. They are soft and non-encapsulated growths.

Cysts.—Mills says that cysts arise about an old hemorrhage, are small retention-cysts of a vascular plexus, or are porencephalic. Dermoid cysts are extremely rare.

Symptoms.—They are divided into two sets: (1) General, due to increase of pressure, and (2) local, localizing, or special, arising because of the part of the brain involved.

In some cases general symptoms are absent, in some special symptoms are absent, in others even tumors of large size produce no recognizable symptoms, either general or special. A large infiltrating growth, a glioma, for instance, may produce no symptoms at all if situated in a silent region, and if it destroys brain substance as it grows, so that intracerebral pressure is not increased.

General Symptoms.—The chief general symptoms are headache, vomiting, and choked disk. All of these may be present, any one of them may be absent, any two of them may be absent, and in some cases all of them are absent. Other general symptoms that may or may not be present are vertigo, general convulsions, insomnia, mental failure, and somnolence or partial stupor.

Headache.—This is the symptom most commonly present. It occurs sooner or later in a very great majority of cases.

At first it may be noted only at certain times of the day and it is usually complained of most on rising in the morning. The headache of brain tumor when once established is intense in most cases, and as a general thing it is practically continuous, with episodes of increased violence. In rare cases it is paroxysmal. In some cases it is trivial, in some few cases it never arises at all. The headache of brain tumor usually interferes with sleep. It may be general, one sided, frontal, or occipital. The situation of the pain is without localizing value unless there is tenderness on percussion or pressure over the seat of pain, which is sometimes noted in growths of the meninges or cortex.

Headache is less common in children. In very young children the explanation of this is found in the open fontanelles and the expansile cranium—In older children in the fact that gliomata are common in children and gliomata may not cause intracerebral pressure.

The dura is sensitive, as Cushing says to "pull or pressure, not to an inci-

sion." The headache of brain tumor is due to stretching of the dura.

Vomiting.-Vomiting is present at times in many of the cases. It may

happen occasionally or it may never occur.

It is usually cerebral, that is, vomiting with a clean tongue without nausea, and without any relation to the taking of food. In some cases it is projectile, quantities of vomitus being suddenly projected from the mouth. It may, however, be associated with nausea, and in some cases there is nausea without vomiting. It is apt to be most severe on getting up, especially on rising in the morning. It is apt to be most severe when headache is most intense.

The worst attacks of vomiting occur in cases of cerebellar tumor.

The cause of vomiting is uncertain. Some believe it to be due to stimulation of the vagus center, others, to reflex stimulation of a vomiting center in the medulla. If associated with vertigo it may arise from the auditory centers.

Choked Disk (Optic Neuritis, Papillitis, Descending Neuritis, Papillo-edema).—This is a most important symptom. When present it is, as Cushing says, one of the "most reliable" signs of tumor. It is present in 80 per cent. of all cases. It may be noted in a few weeks after a tumor begins to grow,

in a few months, or longer. It may come on rapidly or gradually.

It is particularly common and severe in growths beneath the tentorium. It is decidedly less common in tumors of the motor cortex. It is nearly always bilateral, but it is common to find it more marked in one eye than in the other. That it is worse on one side *suggests*, but *only suggests*, that the tumor may be on the side on which the choked disk is worst. Monocular choked disk is very rare. When it exists it indicates that the growth, in all likelihood, is situated near the back of the orbit on the same side as the choking of the disk. Gowers recently recorded a case of unilateral choked disk due to a tumor compressing the left optic nerve ("Lancet," July 10, 1909).

Choked disk may exist for some time and attain a high grade without noticeably impairing vision, but ultimately it leads to retinal hemorrhage, white atrophy, and blindness. When atrophy begins vision wanes. The presence of choked disk does not prove the existence of tumor. The cerebral edema of Bright's disease may cause a condition known as albuminuric retinitis, which practically is not to be distinguished from the choked disk caused by tumor. Cushing believes that the processes are identical in tumor and Bright's disease. Choked disk may occur in meningitis, brain abscess, cerebral syphilis, sinus thrombosis, myelitis, infectious diseases (typhoid, influenza, diphtheria, and other conditions), toxemias from lead, arsenic, and alcohol, anemia, diabetes, or as an hereditary or family disease.

The cause of choked disk has been much disputed. Some believe that the condition is a neuritis due to a toxic condition of the cerebrospinal fluid. Others believe that it is not inflammatory, but is a papillo-edema due purely to mechanical pressure, and is an edema or dropsy. The latter theory is largely held by surgeons because they have become convinced by experience that relief of intracranial pressure relieves or cures choked disk. De Schweinitz and Hollaway ("Therapeutic Gazette," July 15, 1909) make the following state-

ment in regard to mechanical pressure causing choked disk: "That this is the only etiological factor may with propriety be disputed; indeed, it seems certain that a combination of factors must be active in the production of this condition, but increased intracranial pressure is the one of which we have most certain knowledge."

Cushing, of Baltimore, who has done such notable work on this subject, believes that "almost all, if not all cases of choked disk are primarily of mechanical origin and do not justify the term neuritis" ("Keen's Surgery," vol. iii). The presence of choked disk is disclosed by the ophthalmoscope.

Convulsions.—Generalized convulsions may occur and children are especially liable to them. Many cases of supposed general convulsions have an unobserved local beginning which is a focal symptom.

Vertigo.—Mills says it is noted in one-third of all cases and is due to dural, ocular, or labyrinthine irritation.

Insomnia is often due to headache and is apt to be associated with restlessness, lack of emotional control, and irritability. It is most pronounced in cases of syphiloma and some forms of malignant disease, and is worse in adults than in children.

In rare cases there is somnolence or partial stupor rather than insomnia. In such cases slow speech is often noted.

Mental Failure.—There is often great lack of emotional control, characterized by irritability and outbreaks of anger. Failure of memory is common and change of character is the rule. There may be great slowness of thought and of mental response to stimuli, with defective power of orientation. Progressive mental deterioration may occur. There may be mental depression, apathy, or mental excitement. Tumors in certain regions may cause delusions, illusions, or hallucinations.

Hysteria and neurasthenia sometimes arise.

Pulse and Respiration.—Whereas the pulse is often slow, it is very variable, and I agree with Cushing that "pressure symptoms which characterize acute lessions (namely, rise in blood-pressure; slow, vagus pulse, and Cheyne-Stokes piration) are conspicuous by their absence" ("Keen's Surgery," vol. iii).

Special Focal or Localizing Symptoms.—These symptoms, when present, indicate the situation of the growth. If the tumor is in a silent region there will be no focal symptoms. General symptoms may exist without focal symptoms and focal symptoms may exist without general symptoms.

Among localizing symptoms we should mention various forms of aphasia, hemianopsia, paralysis, Jacksonian epilepsy, sensory disturbances (to touch, pain, or temperature), sensory aura, disturbances of taste and smell, impairment of muscular sense, alteration or impairment of reflexes, nystagmus, and incoordination.

Diagnosis.—In abscess the symptoms develop much more acutely than in tumor. It is true that some cases of abscess last for months, but in them intervals of complete remission of symptoms occur, which is not the case in tumor. An abscess follows middle-ear disease or some other pyogenic process or perhaps a head injury. There may be fever and leukocytosis. Choked disk is far less common than in tumor.

Chronic meningitis from syphilis exhibits periods of increase and periods of subsidence of the symptoms, and usually palsy of one or more cranial nerves. The symptoms may pass away under the use of mercury and iodid of potassium.

Examination of the fluid obtained by lumbar puncture may make the diagnosis evident.

In *Bright's disease* symptoms strongly suggestive of tumor may arise (headache, vomiting, and choked disk) with, perhaps, but little change in the urine. The difficulty in diagnosis becomes evident when we recall that in cases of brain tumor the urine may contain casts and albumin.

Ependymitis with ventricular dropsy may cause symptoms resembling

tumor with hydrocephalus.

The x-rays may aid us in diagnosis and many brain tumors can be skiagraphed. Lumbar puncture may aid in the diagnosis, but it must be used with the greatest care, because in tumor the withdrawal of any considerable quantity of fluid may be followed by sudden death.

Cause, Duration, and Termination.-A brain tumor, unless caused by

syphilis, is a certainly fatal lesion if not removed by operation.

Some brain tumors grow for years before they produce symptoms. Some grow with great rapidity. When pressure symptoms appear the patient's life will terminate in a few months unless an operation is performed. It is usually stated that the average duration of life is three years.

Sudden death may occur at any time.

Horsley states that in a very few cases brain tumors have disappeared after mere operative exposure, the tumor not having been removed. Cushing has had the same experience, and regards such an amazing disappearance as

due to the cystic degeneration of a glioma.

The situation of a tumor is determined not only from localizing symptoms but also from their mode of onset and manner of combination. In some cases the symptoms are not characteristic, in others they are definite. The more marked the signs of compression, the less the value of localizing symptoms. The nature of the tumor, its depth, and whether it is single, and if other tumors exist is, if possible, determined. Localizing symptoms may be due to irritation or destruction of functionating power. Irritation causes spasm, and destruction induces paralysis. Convulsions which are local or which begin locally are known as Jacksonian epilepsy. A local convulsion points to an irritative lesion of, or immediately adjacent to, the center which presides over the muscular movements of the part convulsed. Local paralysis points to a destructive lesion of the center which presides over the movements of the paralyzed part. In some cases a center is damaged and the muscular movements it controls are paralyzed, but the adjacent brain-areas are irritated and the muscles they represent are attacked with spasms. In some cases an apparently paralyzed part becomes convulsed, the center not being completely destroyed and sudden hyperemia serving to awaken spasm-Always note the order of invasion of different regions and observe if spasm is followed by muscular weakness or anesthesia.

r. Lesions in the Cortical Motor Area.—A slow-growing tumor which irritates the cortex will cause tonic or clonic convulsions on the opposite side of the body. These convulsions have a local beginning (Jacksonian epilepsy). After a time paralysis may develop (monoplegias and perhaps, ultimately, hemiplegia). An irritative lesion of the lower third of this area causes spasm of the opposite side of the face, angle of mouth, or tongue; and this condition is often associated with tingling. The spasm may remain limited or may extend widely, and may even become general. An irritative lesion of the middle third of the

cortical area causes spasm, which is limited to or begins in the fingers, thumb, wrist, or shoulder. An irritative lesion of the upper third of the cortical motor area causes spasm, which is limited to or begins in the toes, ankle, leg, or hip. If such lesions exist, an aura is occasionally felt in the affected region before the spasm begins, and there is often numbness after the spasm. Destructive lesions of the motor area cause local paralysis, which may be preceded by local spasm of the same parts, and is often associated with local spasm of other parts. If paralysis comes on unpreceded by convulsions the lesion is subcortical rather than cortical, that is, it is in the white matter between the motor area and the internal capsule.

2. Tumors of the anterosuperior portion of the prefontal region give no definite localizing symptoms, but produce general symptoms. Mental disorders may arise in tumors of any area of the brain, but in tumors of the prefrontal region they are most apt to occur. The intelligence is nearly always impaired, and there is apt to be mental apathy, loss of memory, irascibility, and pronounced change of character. As the tumor grows it may subsequently involve the motor region, which in all probability lies entirely in front of the fissure of Rolando.

In tumors of the prefrontal region there may be focal convulsions or local palsy on the opposite side, due either to a spread of irritation from a superficial tumor to the motor cortex or to involvement by a deep tumor of the commissural fibers which join the frontal lobe and the motor cortex.

3. Tumors of the Antero-inferior Portion of the Frontal Lobe.—
In a right-handed man tumor of the second left frontal convolution causes agraphia, and of the third left frontal convolution, motor aphasia. In a left-handed person these localizations are on the right side of the brain.

4. Tumors of the parietal lobe may occupy a silent region of this lobe. The centers for general sensibility and for the muscular sense are back of the fissure of Rolando in the parietal lobes. Hence a tumor in this region may cause disturbance of muscular sense and general sensibility in the limbs without spasm or palsy (Durante). There may be word-blindness when the left angular gyrus is affected.

The extension forward of a parietal tumor will involve the motor zone and produce spasm or palsy. Extension backward will involve the occipital lobe and produce hemianopsia.

5. Tumors of the occipital lobe are apt to produce lateral homonymous hemianopsia (blindness of the nasal half of one retina and the temporal half of the other retina. If the right side of the brain contains the lesion the right side of each retina is blind, and vice versâ). Lesions of the cuneus and of the calcarine fissure are especially apt to produce hemianopsia. A lesion of the occipital cortex may produce it. Tumors of both occipital lobes cause blindness. In tumor of an occipital lobe color vision only may be affected (Cushing). Tumor of the optic radiation may produce hemianopsia (that is, growths of the chiasm, optic nerve, a pulvinar may, but it is not certain that a growth of the quadrigeminal bodies or of the external geniculate body can).

6. Tumors of the temporosphenoidal lobe frequently produce no symptoms. In the temporal lobes the cortical centers for hearing are placed, and each center is connected with both auditory nerves, but the crossed auditory bundle is larger and more active than the direct (Francesco Durante, "Brit.

Med. Jour.," Dec. 13, 1902). Tumors in the left lobe are particularly to cause deafness and may cause word-deafness. Tumors at the apex of lobe may cause perversion or impairment of taste and smell.

- 7. Tumors of any size in or about the corpus striatum cause he plegia by pressure upon the internal capsule. Pressure upon the optic the mus produces homonymous hemianopsia and hemianesthesia. Growths the basal ganglia produce intense optic neuritis and early pressure because distention of the ventricles. Tumors of the corpora quadrigemina are to involve the crura, and later the third nerve. Ocular symptoms are alto present (loss of pupillary reflex and nystagmus). If the third nerve is involved there are paralysis of the motor oculi area on the side of the lesion (extension strabismus, dilated pupil, and drop-lid) and hemiplegia of the opposite side the body from pressure upon the crus. This condition is a form of creparalysis.
- 8. Tumors of the Pons.—Pontine lesions produce symptoms by presupon the particular nerves which come from this region, with or wit the evidences of pressure upon the motor path. Forms of crossed paramay exist. Lesions in the lower half of the pons may effect the fifth, s and seventh nerves on the side of the lesion and the limbs on the opposide. The auditory nerve may be involved in the lesion. In crossed paysis the face on the side of the limb paralyzed is usually not affected, be extensive tumors it may be paralyzed. Conjugate deviation of the eyes occur away from the facial paralysis. In tumors of the upper part of the the pupils may be first contracted from irritation of the third nerve nu and later dilated from destruction of these nuclei. Anesthesia as a not pontine tumors is not nearly so common as is motor paralysis, and consions are rare.
- 9. Tumors of the Medulla.—An extensive lesion inevitably ca death. Cranial nerves only may be involved, but crossed paralysis may place. Vomiting is common, retraction of the head is not unusual; resp tory and circulatory disturbances and dysphagia are frequently noted; so times there is numbness and occasionally there are convulsions; usu there is incoördination, because of pressure upon the cerebellum.
- ro. Tumors of the Cerebellum.—In general it may be said that tunof the cerebellum cause headache, vomiting, vertigo, choked disk, and a blindness. Tumors of the middle peduncle cause sudden uncontrol movements of the trunk, either toward the side of the tumor or away it. Vertigo and nystagmus are common. Symptoms are frequently a plicated by evidences of pontine disease proper.

Tumors of the middle lobe of the cerebellum cause a sense of lost e librium and obvious unsteadiness in attempting to walk or even to st The patient has a tendency to fall; there are giddiness and vomiting.

Tumors of the cerebellar hemisphere produce no localizing sympts. The usual unsteadiness of gait is due to pressure upon the middle lobe (N nagel).

11. Tumors of the Hypophysis Cerebri.—The pituitary body may subjected to pressure from, or become involved in, tumors of the region about tumors or cysts may spring from it directly. Tumors of or tumors mapressure upon the hypophysis may in some cases cause acromegaly, an

others impotence, genital infantalism, a tendency to fat deposit, and stunted stature. There is intense headache, amblyopia due to primary atrophy (no preceding choked disk), appearing often as a bitemporal hemianopsia (Cushing, "Jour. American Med. Assoc.," July 24, 1909).

Any brain tumor which causes internal hydrocephalus may thus cause pressure on the hypophysis and lead to the development of hypophyseal symptoms

(Cushing).\*

Treatment.—If any doubt exists as to the nature of a brain tumor, give the patient a course of iodid of potassium, and as doubt is the rule, we almost invariably administer it. Give the drug at first in small amounts, but rapidly increase it until heroic doses are taken (100 or more grains a day). Mercury should also be given hypodermatically or by inunction. If iodid of potassium and mercury really relieve the symptoms, and if the improvement

is not merely temporary, operation is unnecessary, although it may be demanded later in order to remove an irritant scar. If antisyphilitic treatment fails, the question of operation must be considered. The test of success is improvement in the choked disk. If this improves, the treatment is succeeding, if it does not, the treatment is a failure. It should not be persisted in over six weeks if there is no improvement in the eye grounds. To delay operation further may mean blindness. We must always bear in mind that in certain cases of glioma the symptoms temporarily improve under antisyphilitic treatment. The term operable case does not of necessity mean a tumor which can be entirely removed by operation. Some tumors which can be only partially removed should be



Fig. 463.—Case of cerebellar tumor. Bulging of flap after osteoplastic exploratory operation.

made to remove the tumor and in which the tumor can be entirely removed or in which a part can be removed, the removal of this part promising relief. We are justified in being radical because without operation a brain tumor is a certainly fatal malady. In many cases of undoubted tumor excision for cure is not attempted because of the absence of localizing symptoms or because of the inaccessible situation of the growth. In all cases operation is, first of all, exploratory. Tumors of the dura which have not infiltrated the brain, many cortical and some subcortical growths, are operable. Cerebral cysts if accessible should be opened and drained in hope that

<sup>\*</sup>For full consideration of localizing symptoms see particularly the writings of Gowers, Mills, Allan Starr, Dana, Dercum, Osler, and Cushing, which have been freely used in the above section.

benefit will result. Some subtentorial tumors can be removed. In certain cases it is justifiable to attempt the removal of a glioma if the growth is in an accessible region. Byrom Bramwell maintains that tumors at the base, tumors of the pons and medulla, of the corpus callosum, of the basal ganglia, and of the deeper parts of the centrum ovale are irremovable. Most tumors at the base are inoperable, but some few are operable. Surgeons now regard some tumors of the cerebello-pontine angle as operable, but agree with Bramwell's views as to growths in the other situations he mentions. Frazier has concluded that "if the tumor is found to be very vascular and of the infiltrating type, it is very questionable . . . as to whether any attempt whatsoever should be made to extirpate" ("Univer. of Penn. Med. Bulletin," April-May, 1906), and with this opinion I certainly agree. In tumors which are very extensive complete removal is usually out of the question. There is no use in removing secondary malignant tumors. It often happens that the brain itself (as in syphilis) is so extensively diseased, or that other organs (as in tuberculosis) are so involved, as to render attempts at removal of the tumor futile or actual removal useless. Mills thinks that 50 per cent. of cerebellar tumors can be attacked surgically ("New York and Phila. Med. Jour.," Feb. 11-18, 1905). He classifies operable tumors of the cerebellum as follows: 1. Tumors situated entirely or chiefly in the lateral lobe. 2. Tumors upon or even invading a part of the vermis or middle lobe. 3. Tumors of the cerebellooblongatopontile angle. Among inoperable tumors are most gliomata and infiltrating sarcomata, metastatic tumors, and multiple tumors. Bramwell tells us\* that he has studied eighty-two cases of intracranial tumor, and he considers that in only five of them could the tumor have been entirely removed. In 157 reported cases the tumor was either not found or not removed; in 104 reported cases the tumor was found, and in some of them it was removed (Ransohoff, in "Jour. Am. Med. Assoc.," Oct. 11, 1902). The conclusion is that though some tumors of the brain may be successfully removed, extirpation is feasible in only a small minority of cases and is to be decided on only after careful study of all the indications and contraindications offered by the case. When an operation is decided upon, some surgeons apply an apparatus to the arm and the blood-pressure is taken just before the operation and at frequent intervals during it. Thus by noting a great fall in blood-pressure they get early warning of dangerous shock, learn when to hasten, and if the operation should be temporarily abandoned and be completed at another time (two-stage operation). We may be driven to abandon operation after cutting the bone and dural flaps, and if we are forced to stop, we restore the bone and dura to position, and complete the operation after a day or two. I agree with Frazier that the lessening of hemorrhage by temporarily clamping the carotids in the neck is not free from danger, and it is not proper to do more than apply Crile's clamp to the vessel on the side operated upon. In a braintumor when the dura is first opened there is usually at once marked bulging of the brain, which is called "initial bulging"; after working for a time on a brain, even when there is no tumor, bulging occurs from traumatic edema, which is called "consecutive bulging." That consecutive bulging may occur is a sound reason for operating rapidly (Frazier). The mortality from tumor operations is large, death being due to shock and hemorrhage. Haas col-

<sup>\*</sup> Edinburgh Med. Jour., June, 1894.

lected 122 cases in which the tumor was removed; the mortality was 60 per cent. Operations completed at one séance give a larger mortality than twostage operations. During the operation an erect posture causes the brain to recede and permits of extensive exploration under the dura (Ransohoff-Cushing). The same thing is accomplished by lumbar puncture (Cushing). The fibromata constitute the best cases for operation. In operating on a cerebral tumor make a large osteoplastic flap. If on opening the dura the tumor is not visible, and if the localizing symptoms were reasonably positive, the surgeon is justified in making an exploratory incision through the cortex to see if there is a subcortical growth. Operations for cerebellar tumors are peculiarly difficult because of the large blood sinuses, because of the limited space obtained to work through, because of the great bulging after the dura has been opened, because of the impossibility of reaching the anterior, mesial, or upper surfaces through the incision, because of the liability to injure the pons and medulla, and because of the difficulty of retracting the parts (Frazier, "New York and Phila. Med. Jour.," Feb. 11-18, 1905). In approaching tumors which are not within a cerebellar hemisphere by a one-sided exposure of the cerebellum, it is usually best to remove a considerable portion of the hemisphere in order to obtain free access to the growth. I prefer Cushing's "cross bow" incision and bilateral exposure. This enables the surgeon to dislocate the sound lobe outward and so obtain room to work upon the lobe containing the tumor. The diagnosis of cerebellar tumor is usually doubtful, hence practically all operations are at first exploratory and are then made palliative or radical as the case demands. Operation must be early, because cerebellar growths quickly cause blindness. Sir Victor Horsley, McArthur, Hochenegg, Von Eiselsberg, and Cushing have operated for tumor of the hypophysis. Removal of a healthy pituitary body from dogs is sure to be fatal, as the gland is necessary to the life of the dog. Removal of a healthy pituitary in man would in all probability prove fatal. Diseased pituitaries have been successfully removed. Perhaps in these cases the function of the gland was more or less compensated before operation was done. If the tumor is associated with acromegaly, removal of the tumor may greatly benefit the acromegaly. One route of approach to the hypophysis is from the side, just as we reach the Gasserian ganglion. Another route is across the frontal sinus, then dividing the septum of the nose, removing the turbinated bones, and breaking through the sphenoid. Though thorough extirpation is feasible in but few cases of brain tumor, operation should often be performed for palliative purposes. Grainger Stewart, Annandale, Horsley, Macewen, Cushing, and Keen have advocated palliative trephining in certain cases. Simple trephining is of little value. In order to really relieve pressure the dura must be opened and left unsutured, so that hernia cerebri may follow. Cushing has had some cases of extraordinary improvement in cases of cerebral tumor after trephining in the right temporal region and removing a piece of the dura. The operation iscalled by Cushing a decompression operation. The brain bulges through the dural opening, but the dense temporal fascia stitched together over it prevents fungation. It is the temporosphenoidal lobe that bulges, and the right side is elected because word-deafness might ensue if the operation were done on the left side. I have seen several of Cushing's cases. One of them, a colored man, had been almost blind for some time and was unconscious and had rapidly

failing respiration when the operation was performed. He was so much benefited that he returned to work and has useful vision and no pain. I have had several very gratifying results in my own practice. In cases of cerebral tumor subtemporal decompression, and in cases of cerebellar tumor suboccipital decompression, may be performed.

Decompression may relieve choked disk and thus retard or prevent optic atrophy and blindness. Cushing demonstrates that intracerebral pressure is

the chief element in choked disk.

This procedure is of value in diminishing excessive intracranial pressure, and thus relieving headache and choked disk, and decreasing the tendency to sudden death from inhibition of the heart or from respiratory failure. The usual method of decompression will not relieve the headache caused by tumor of the hypophysis. This headache is due to distention of the dural box in which the gland is placed, and can be relieved only by incision of the dural box (Harvey Cushing, "Jour. American Med. Assoc.," July 24, 1909).

We conclude that in most cases of brain tumor operation should be performed for exploration; in some cases extirpation may be performed; in most cases extirpation is impossible, and the surgeon must be content with the palliative influence of Cushing's decompression operation. A tumor of the brain if not cured by antisyphilitic treatment is of necessity fatal if unoperated upon,

and exploratory operation is not very dangerous.

In a case of brain-tumor if operation is refused, if extirpation is impossible, or if decompression fails, it may be necessary to use the bromids for convulsions and morphin for headache. The headache is often benefited by purgatives, courses of potassium iodid, the ice-bag to the head, and the application

of a hot iron to the nape of the neck.

Operative Treatment of Epilepsy.—The shock of an accident or a cerebral concussion may establish epilepsy, especially in those predisposed by heredity or other causes. Traumatic epilepsy, Le Dentu tells us,\* may be due to: (1) Bone-fragments from skull-fracture; (2) outgrowths of bone due to tumor; (3) cicatrices of meninges resulting from laceration of membranes by bone-fragments; (4) chronic meningitis which ends in sclerosis of membranes; (5) cysts resulting from intracranial hemorrhage at the point of fracture; (6) arteriovenous aneurysm. We would add: (7) tumors of the brain; (8) sclerosis of the cortex. We refer here, in speaking of traumatic epilepsy, purely to the condition when it follows a head-injury, and this is the common meaning of the term. Remember that epilepsy, as shown by Sachs, may follow a long-forgotten injury. Before undertaking a brain operation for epilepsy it is a sound rule to remove all sources of definite peripheral irritation. I have seen apparent cure follow the removal of a tender cicatrix and follow circumcision of a patient laboring under phimosis. Briggs reported a case of epilepsy in which there was a distinct depression of a portion of the skull. There was also necrosis of the tibia, and after the cure of the necrosis the convulsions ceased. The removal of supposed peripheral irritation, however, is beneficial only occasionally. Are operations upon the skull and brain curative? Surgeons are much less enthusiastic than they were a few years ago. I believe operation can cure less than 5 per cent. of cases, but it is important to remember that in some cases in which operation

<sup>\*</sup> La Presse médicale, June 9, 1894.

seems to have failed medical treatment becomes much more efficient than it was before the operation. The high rate of cure (70 per cent.) once claimed for operations was due to failing to follow the patient sufficiently long. A patient should not be reported as cured until at least three years, and better, five years, have passed without any evidence of the disease. Another source of error was a failure to understand that any traumatism may improve epilepsy jor a time. "The administering of an anesthetic, the shock of an injury, the traumatism of an operation, just like a febrile seizure, may interrupt an pileptic habit and cause a patient to go for weeks or months without an tack" (the author, in "Medicine," Feb., 1904).

Operation must never be indiscriminately applied. In some cases it gives to ope of relief, in others it is obvious that it would be utterly futile. In order determine if a case is or is not suitable for operation it must be studied ith great care. The history must be carefully obtained, particularly as to reditary predisposition, the first convulsion, and its supposed cause. The destion of injury, recent or old, should be thoroughly investigated, and it is a sound rule to have the head shaved and then examine for a scar and for a depression. Convulsive seizures must be studied by an expert, hence the patient should be in a hospital, constantly watched by a trained nurse, until one or two fits have occurred. The nurse watches the convulsion and describes it in writing, noting particularly if it had a local beginning. The general health must be investigated.

I am accustomed, for surgical purposes, to make the following classification of epilepsy. It is a modification of Sir Victor Horsley's classification (the author, in "Medicine," Feb., 1904):

- 1. Reflex epilepsy, the surgical treatment of which I shall not discuss in detail.
- 2. The common non-traumatic, idiopathic, or essential epilepsy, in which the attacks are general and are without a local onset.
- 3. Idiopathic epilepsy with a local onset of attacks (focal or Jacksonian
- 4. Traumatic epilepsy. This may be subdivided into two forms: attacks without a local onset; and (b) attacks with a local onset (focal Jacksonian epilepsy).
  - 5. Jacksonian epilepsy due to gross brain disease (tumor, aneurysm, etc.).
  - 6. Epilepsy following infantile cerebral palsy.
  - 7. The posthemiplegic epilepsy of adults.
- 1. Reflex Epilepsy.—Remove the supposed cause of irritation. When epilepsy follows traumatism and a scar is found on the scalp, excise the scar. This is an imperative duty if the scar is tender or the seat of an aura.
  - 2. Essential or Idiopathic Epilepsy.—Operation upon the brain is useless. If persistent headache exists, it is then proper to trephine and open the
    dura for exploration. Such an operation is done to relieve headache. Some
    claim remarkable results from bilateral excision of the cervical ganglia of the
    sympathetic (page 777). The operation is a theoretical one and of doubtful
    utility. It was founded upon a misconception as to the cause of epilepsy,
    and favorable reports are no more favorable than have been set forth regarding
    various other now abandoned procedures.
    - 3. Idiopathic Epilepsy with Local Onset of Attacks (Focal or Jacksonian Epilepsy).—Many of these cases begin in young children who have had infan-

tile palsy, the traces of the palsy having disappeared. In such cases the convulsions may begin on one side, and in fact may be nearly limited to one side. If, from the very beginning, the attacks began in one group of muscles or in one extremity, whether or not they spread to the rest of the body, and if the case is seen within two years of the first attack, the surgeon is justified in exposing the brain and excising the irritated portion of cortex. This operation, it is true, cures very few cases, but it benefits many for a considerable time and seems to make them more amenable to medical treatment. In the vast majority of cases fits recur, but rarely as severely as before. After fits have been going on for two years operation offers no prospect of cure, as the association fibers have surely degenerated. But, even in very old cases, if the attacks are frequently repeated and thus threaten life, the excited center should be removed to save life.

In cortical excision more of the cortex than the excited center is of necessity removed, because, in order to get the entire center, we must go wide of it. Paralysis of the parts controlled by the extirpated cortical area follows. The paralysis is seldom permanent except to the finer movements. The operation gives the best prognosis in young persons, and when done early in the case. The return of fits after apparent cure is thought to be due, at least in some cases, to the formation of adhesions between the brain and its membranes. Various unsatisfactory attempts have been made to prevent adhesion by the insertion of silver foil, gold foil, rubber tissue, egg-shell membrane, and Cargile membrane. In operating for cortical epilepsy a large osteoplastic flap is required. In the previous remarks we dealt with partial epilepsy and with generalized epilepsy in which, from the first, the attacks had a local beginning. If cases of apparent idiopathic epilepsy develop Jacksonian attacks (attacks with a local beginning), it is useless to excise the cortex. The entire cortex is diseased, though one region is particularly unstable.

4. Traumatic Epilepsy.-Always remember that a traumatism to a person who becomes epileptic may have been only a coincidence; the condition may be essential epilepsy and the traumatism may have had nothing to do with it. Epilepsy ensuing upon traumatism may not begin until months or even several years after the injury. In the earliest attacks consciousness may or may not be lost. The causative injury may have been slight or severe. "An injury may cause a hemorrhage or a depressed fracture; may be followed by a scar upon the membranes; may occasionally lead to the development of an innocent or malignant tumor or a cyst, or may merely induce some trivial change in the subtle chemistry of the nerve-cells" (the author, in "Medicine," Feb., 1904). Injury may produce general epilepsy or Jacksonian epilepsy. If an identified traumatism exists, the surgeon should operate even after years. When the traumatism has not left definite evidence, the surgeon is justified in making an exploration any time up to the termination of the third year after the accident. The earlier the operation, the better the prognosis. The best prognosis of any form of epilepsy is given by Jacksonian epilepsy of traumatic origin.

"In focal epilepsy with evidences of skull injury or depression, trephining is imperative and somewhat promising. The dura should invariably be opened, even if it seems in good condition. A dural scar should be extirpated.

The brain should be examined by sight and by touch, and should be explored with the little finger and with the dural separator to well beyond the limits of the opening in the dura. If a tumor is found, it should be removed; if a scar upon the brain exists, it should be extirpated; if a cyst is discovered, it should be drained; and if there is any obviously damaged area in the brain tissue, it should be unhesitatingly cleared away. If nothing obvious is found on exploration, and if the attacks have been distinctly focal in origin, it is justifiable to extirpate the motor center from which the discharge seems to originate.

"When Jacksonian epilepsy has followed an injury in the motor region, the chances of effecting a cure are much better than they are when the epilepsy has followed an injury in the sensory region. When it has followed an injury

in the frontal region, operation affords very little hope of cure.

"When the condition is not focal but essential epilepsy, the surgeon will remove a scalp scar; and if there is any evidence of bone injury, he will trephine the bone, open the dura, and explore the brain. It is needless to say, however, that in such a case he will not extirpate any of the cortex.

"In cases of focal epilepsy I use the osteoplastic method of operating. In cases of generalized epilepsy I use the simple trephine and leave the button of bone out, as a means of effecting a prolonged modification in the intra-

cerebral pressure" (the author, in "Medicine," Feb., 1904).

Bramwell maintains that when traumatism is followed by epilepsy and the epileptic discharge starts from a cortical center which is not beneath the scar, the surgeon should trephine first at the seat of injury, and if this fails, he should trephine over the excited center.

5. Jacksonian Epilepsy due to Gross Brain Disease.—The treatment

of this condition is the treatment of the brain disease.

6. Epilepsy following Infantile Cerebral Palsy.—In this group of cases the palsy is manifest. It is justifiable to operate upon a child but not later in life. The prospect of benefit is poor even in a child.

7. The Post-hemiplegic Epilepsy of Adults.—Operation is useless. Our conclusions are that these operations sometimes seem to cure epilepsy, at so, occasionally, does any operation. White records\* ninety trephinings which, though no cause was found for the epilepsy, great relief followed, do two cases were apparently cured; he mentions benefit or apparent cure llowing tracheotomy, ligation of the carotid artery, incision of the scalp, etc. the same effect may be obtained by a great shock, high fever, the administion of an anesthetic, or an accident. The fact seems to be that any operation, by means of nervous shock, may interrupt the epileptic habit; but in dinary operations the fits tend after a time to recur and soon reach their standard of frequency. In the special brain-operations with removal of the pileptic habit; but in the standard of frequency. In the special brain-operations with removal of the pileptic habit; but in the standard of frequency, and will be more amenable to medical treatment.

In non-traumatic chronic epilepsy without localizing symptoms trephining is not justifiable unless persistent headache calls for it as a means of relief from intracranial pressure. Annandale has recently advised us to consider experimental operation in such cases when the drug-treatment has failed

<sup>\*&</sup>quot;The Supposed Curative Effects of Operations per se," Annals of Surgery, Aug. and Sept., 1891

and when the patient's condition seems hopeless. He says there is no chance of improvement without operation, and operation may possibly disclose a removable lesion.\* After trephining for epilepsy five years should elapse without a convulsion before cure is reasonably assured; and if convulsions arise, they must at once be met by medical treatment. A man having once had a convulsion may at any time have others; hence he should always be watched. It is not unusual for a few convulsions to occur soon after an operation for epilepsy, and then to cease for a considerable time. These early fits result from habit (habit fits). Among the operative procedures suggested for the treatment of epilepsy may be mentioned circumcision, clitoridectomy, ocular tenotomy, ligation of the vertebral arteries, removal of the cervical ganglia of the sympathetic (page 777) (Alexander, Jonnesco, Jaboulay), and the actual cautery to the head (Féré).

Operative Treatment of Insanity (see the author in "Journal of Ner-

vous and Mental Diseases," June, 1904).

r. Epileptic Insanity.—The conditions which call for operation on a non-insane epileptic (page 837) call for it on an insane epileptic. It is sometimes justifiable to operate if there has been a head injury, and operation may lessen the number and diminish the violence of the attacks. If focal seizures exist, we may proceed as for focal seizures in the sane. In status epilepticus we may operate to relieve pressure. It will be observed that operation is for the convulsions and not for the insanity.

- 2. Paresis.—I do not advocate operation in paresis. If we believe in traumatic paresis, we may be inclined to advise operation. Personally I do not believe that genuine paresis is ever cured; the lesions of the disease are widely disseminated; the pons, medulla, and even the cord may be diseased and the lesions cannot be removed.
- Non-traumatic Insanity and Paranoia.—Operation cannot cure the insanity and is not to be advised.
- 4. Hypochondriacal Delusions.—Operation is useless. Some practice it with the idea of getting rid of a delusion by removing a part to which the attention is directed. Such attempts always fail, because it is the insanity which causes the delusion, not the delusion which causes the insanity.
- 5. Operations for Traumatic Insanity.—A pyschosis constructed on the basis of a traumatic neurosis never calls for operation. The only cases in which operation is ever justifiable are those in which traumatism is the direct cause. Insanity may begin at once or soon after an injury, but is often unrecognized for weeks or even months. Nearly all of these cases are predisposed to insanity and the injury has been only an exciting cause. Traumatism is the direct cause in about 2 per cent, of cases of insanity.

"An antecedent injury may have directly induced the alienation; it may have had no bearing at all upon the latter; or it may have produced an insanity by fear and shock, and not by creating a direct brain lesion. Again, the head injury, by increasing the individual's susceptibility to alcohol and to the effects of the sun, may, if this person drinks alcohol or exposes himself to the rays of the sun, be indirectly responsible for lunacy.

"In insanity following an injury to the head there may be various supposed causative lesions: A fracture of the skull, with or without depression;

<sup>\*</sup> Edinburgh Med. Jour., April, 1894.

the development of an exostosis; sclerosis or softening of the cortex; edema of the membranes or of the brain itself; cerebral hyperemia or congestion; thickening of the membranes; adhesion of the membranes to the skull, to each other, or to the brain; new-growth; inflammation of the membranes; or minute, slowly developing, wide-spread nutritive changes. The injury may be assumed to be the cause of the insanity if the insane condition becomes manifest almost at once or soon after the accident; but if the symptoms do not appear until long after the accident, the traumatism may be considered to be the directly exciting cause in some cases, and not in others. It may be blamed if, between the time of the accident and the appearance of the insanity, there has been a marked change in the patient's disposition, temperament, or character; if he has developed headache, insomnia, irritability, passionate outbreaks of temper, moodiness, or lapses of memory; if he has plunged into immorality or excesses in alcohol; if he has displayed a tendency to neglect business or family obligations; and if he has shown increased susceptibility to alcohol and to the sun. Sometimes epilepsy may develop during this period. (Richardson, 'American Journal of Insanity,' July, 1903. The author's 'Address on Surgery,' delivered before the meeting of the Medical Society of the State of Pennsylvania, May 18, 1897.) If there were none of these intermediate changes in the normal mode of thinking and way of acting, one cannot count the traumatism as causative. Many persons that have received severe head injuries have shown these changes, but have never gone insane. I have been studying this point for a number of years, and have decided that quite a few patients that have been trephined for fracture or for meningeal hemorrhage have subsequently shown pronounced and permanent changes in character and disposition. Of the number that show such changes, many never go insane, but some do. Such an insanity is distinctly traumatic in origin." (The author in the "Journal of Nervous and Mental Diseases," June, 1904.) The prognosis is very unfavorable; some recover after operation, many do not. Some recover without operation. Sometimes operation cures by removing a lesion; sometimes by shock, etc. Some cures following operation did not result from the operation.

On what cases should we operate?

We should operate on cases "in which insanity has soon followed a head in jury; if the site of the trauma is indicated by a scar, a depression of bone, local tenderness, fixed headache, or some localizing symptom,-motor or Sensory,-operation should positively be undertaken. In a case in which the insanity has developed later, in which the intermediate period between the injury and the development of the insanity has shown the change from the normal mode of thinking and way of acting previously alluded to, and in which the site of trauma is indicated by any of the evidences mentioned above-operation should positively be performed. One should not operate upon a case simply because there is a dubious record of an antecedent fall or blow, which merely suggests the possibility of a traumatic origin for the insanity. In any case in which there are positive signs of increased pressure it may be considered proper to trephine as a palliative measure." (The author in the "Journal of Nervous and Mental Diseases," June, 1904.)

Abdominal, Gynecological, and Genito-urinary Operations.- If an insane person has a disease which is dangerous to life or which is productive of pain, discomfort, or ill health, he or she is entitled to be cured, if possible, by a surgical operation. The removal of pain and other depressing influences may result in great improvement in the general health and in notable mental improvement. The operation may thus indirectly exercise a beneficial influence on the insanity, but the influence is not direct and it is never justifiable to do such an operation as oöphorectomy upon an insane woman unless the condition of the ovaries would call for it in one not insane.

Operations on the Skull and Brain.—As a preliminary it is well to note that urotropin given by the mouth quickly appears in the cerebrospinal fluid, and that the fluid contains the maximum amount in from one-half bour to an hour after ingestion. The presence of this drug decidedly inhibits the growth of bacteria in the fluid. We believe it wise to give this drug in all cases in which meningitis is threatened or exists (S. J. Crowe, in "Johns

Hopkins Hospital Bulletin," April, 1909).

Trephining (for a Fracture of the Skull).-Shave the scalp, scrub it with ethereal soap and sterile water, wash it with sterile water and then with alcohol or ether, scrub with a brush wet with corrosive sublimate solution (1: 1000), and wrap the scalp in wet corrosive sublimate gauze (1: 2000). The instruments required are a scalpel, a dissector, hemostatic, dissecting, and mouse-toothed forceps, trephines of several sizes (Fig. 464), a periosteum elevator, Hey's saw, rongeur forceps, a bone-elevator, scissors, straight and curved on the flat, a dural separator, a tenaculum, small curved brain needles and large curved needles for the scalp; a needle-holder; catgut, fine silk, silkworm-gut, and Horsley's wax. Provide a sand-pillow. The patient should be anesthetized unless he is unconscious, and should be placed upon the back with the shoulders a little raised. A sand-pillow is placed under the neck, and his head is turned away from the side to be operated upon. The position of the surgeon is such that the patient's head is a little to his left. A large semilunar incision is made with the base down, which incision goes through the periosteum, and the flap is lifted. The bleeding vessels of the flap are caught with forceps. The fracture is sought for and found. The pin of the trephine is projected beyond the crown and is set upon sound bone, the crown overhanging the line or edge of the fracture. The surgeon tries to avoid the region of a sinus or large artery. A gutter is cut in the bone, the pin of the instrument is withdrawn, and the trephining is completed. In going through the diploë bleeding is copious. The inner table feels very dense. Stop from time to time, clean



Fig. 464. - Galt's conical trephine.

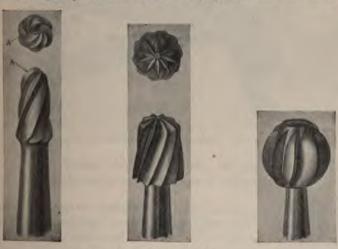
out the gutter in the bone with the dissector, and try the bone with an elevator to see if it is loose. When the fragment is loose enough, pry it out. If the surgeon desires to replace the button, hand it to an assistant,

who places it at once in a bowl of warm normal salt solution, kept warm by standing in a basin of water at 105° F., or who puts it in warm carbolized towels. The edges of the opening should be rounded with a rongeur, and the bone, if depressed, must be elevated. Sometimes it may be necessary to remove splinters and fragments of bone. After removing the fragments the edges of the opening should be smoothed by the use of the rongeur forceps. The

dura should be examined to see if injury exists, and hemorrhage must be stopped. Bleeding from the dura is arrested by passing a ligature of silk or catgut threaded in a small curved needle under the vessel on each side of the wound, and tying the ligatures (suture ligatures). Bleeding from the pia is arrested by direct ligation, by suture ligature, or by gauze packing. Bleeding from the diploë is arrested by the use of Horsley's wax. The wound is cleansed, the edges of the dura are sutured with catgut or fine silk; in some cases the button of bone is reintroduced, in other cases some chips are cut from the bone and scattered upon the dura, but in most cases no attempt is made to fill up the gap in the bone. The scalp is sutured with silkworm-gut, and horse-hair or gauze drainage is employed for a day or two. Sterilized gauze dressings are put on, a rubber-dam is laid over them, and a gauze bandage wet with bichlorid of mercury is applied.

Instead of the trephine some surgeons use the chisel or gouge and hammer to remove a portion of the bone. Other operators, believing that this procedure may cause concussion, employ the surgical engine.

Osteoplastic Resection of the Skull.—Wolff suggested this operation, and in 1889 Wagner performed it. It is employed for the removal of tumors



Figs. 465-467.-Hudson's burrs.

and the Gasserian ganglion, for focal epilepsy, and for exploration. It is the operation of choice when a large opening is needed, as when the operation is, first of all, for diagnosis. A horseshoe-shaped incision is made through the scalp and periosteum; a groove corresponding to this incision is cut in the bone by special gouges or chisels. Some surgeons prefer a saw attached to a surgical engine; some make trephine openings and then cut from within outward by the Gigli wire saw (Obalinski). Cushing, of Baltimore, does what is called the *combined* method. I prefer this to any other plan. It is rapid and free from all danger of wounding the dura. I make two or several openings with Hudson's burr. This excellent instrument divides bone with great rapidity, but does not divide the dura. In fact, one cannot divide the dura with it, for the burr binds as soon as it is through the bone. Figs. 465-467

shows Hudson's burrs. The sides of this bone flap are rapidly cut down by Hudson's improvement of the DeVilbiss forceps (Fig. 468). The upper margin is cut on a bevel with the Gigli saw. Because of this bevel when the flap is restored to place the upper edge of the flap restson a shelf of bone and does not press on the brain. By whatever method performed, three sides of the bone-flap are cut through, but the bone is left attached to the scalp. It is a good plan to save the scalp from detachment by temporarily nailing it in place. The bone is then broken outward, the fracture taking place at the base of the bone-flap, the dura is opened a little distance from the edge (sufficient space being retained for sutures), and the exploration is made and the operation is performed. When we are ready to suture the dura, we note if the brain bulges greatly. If it does, manipulation will surely injure it, and we should cause the brain to recede before suturing by placing the patient nearly erect or by



Fig. 468.—Hudson's modified DeVilbiss forceps.

performing lumbar puncture. After suturing the dura the bone which is still adherent to the pericranium is restored to its proper place, and the scalp is sutured.

Besides restoring a flap of bone into position, or replacing a button of bone, or strewing the dura with bone-fragments, other methods of closing the opening have been practised—for instance, heteroplasty with a decalcified bone-plate and heteroplasty with a celluloid plate or other foreign material.\*

Osteoplastic Resection of the Skull by the Use of Stellwagen Trephine.—
The concussion inflicted by the mallet I believe adds to shock, may increase or cause hemorrhage, may extend a line of fracture or produce fracture, and may diffuse a purulent collection. For these reasons I prefer a different plan. The surgical engine gives satisfaction to some, but it is difficult to render it sterile, and it runs at such a high rate of speed that regulation is troublesome and the instrument is dangerous except in the most careful hands. The trephine shown in the cut (Fig. 471) has proved satisfactory. It has since been modified by substituting screws for spikes in the pivot plate. Dr. Park suggested putting a handle to the spiked plate to keep it from slipping. The area of bone to be removed is carefully determined, as suggested by Mills (see Figs. 469 and 470), the plate is screwed into the skull.

<sup>\*</sup> See Bretano, in Deutsche med. Woch., May 17, 1804.

the scalp is cut with the knife-blade, the base of the flap being made narrow; the saw is substituted for the knife in the instrument. The bone is cut by short, quick cuts, making no attempt to swing the saw through the entire length of the incision at each turn of the wrist. When the inner plate is nearly cut through, the division is completed by a small osteotome. The operation can be completed on an ordinarily thick skull in from eight to eighteen minutes. (See article by author in "Annals of Surgery," July, 1903.) I still use this method, but not so frequently as formerly, preferring Cushing's combined plan to any other.

Trephining the Frontal Sinus.—This operation may be employed for inflammation of the lining membrane of the sinus or for empyema. Make a vertical incision in the middle of the forehead, starting one and one-half inches above the nasion and terminating at the root of the nose. The button of bone is removed and the opening is enlarged if necessary. The mucous

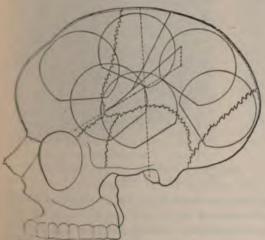


Fig. 469.—Cranial areas for osteoplastic operations with the Stellwagen trephine, these areas corresponding to the regions of the left hemicerebrum, with definite syndromes (Mills).



Fig. 470.—The motor region outlined on the skull previous to osteoplastic operation with the Stellwagen trephine: x, Point for the insertion of the pin of the Stellwagen trephine; y-z, base line (Mills).

a drainage-tube is passed into the nose is found and is dilated, and a drainage-tube is passed into the nose from the sinus, the upper end being left in the sinus. In some severe cases Jacobson advises us to curet the sinus, to disinfect it by the use of silver nitrate or chlorid of zinc, and to insufflate an "aseptic powder." In some cases resect the mucous membrane. I prefer an osteoplastic resection to trephining the frontal sinus.

Trephining the Mastoid (operation for mastoid suppuration, page 848).

Technique of Brain-operations (after Horsley and Keen).—Instruments as for fractured skull. In focal epilepsy a faradic battery is required. Always shave the scalp, and always antisepticize it. In localizations, mark out the fissure upon the scalp with an anilin pencil, with iodin, or with silver nitrate. Have the patient semirecumbent. Mark three points upon the bone with the center-pin of the trephine before incising the scalp (both ends

of the Rolandic fissure and the point at which the trephine is to be applied). Make a semilunar flap three inches in diameter, with the base below. Control bleeding in the flap by forceps pressure. If the operation is by trephining, the one and a half inch trephine should be employed, but if a smaller trephine is used, the opening must be enlarged with a rongeur. Before enlarging the opening, separate the dura from the bone by a dural separator. In most cases an osteoplastic flap is preferable to trephining. It is always employed in explorations for tumor. As a rule, open the dura and examine the brain. The dura is lifted by mouse-toothed forceps and is opened with scissors

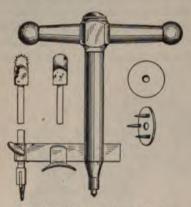


Fig. 471.—Stellwagen's trephine.



Fig. 472.—Combined osteoplastic operation. First step. Incision through superficial tissues and bone.

along a line a quarter of an inch from the bone-edge, a broad pedicle of dura being left uncut. Hemorrhage is arrested by pressure and hot water or by passing a thread of silk or catgut around any bleeding vessel by means of a curved needle. In some cases packing must be retained or forceps must be kept on. In packing, endeavor to use but one piece of gauze, so as to avoid leaving in a forgotten piece. Upon opening the dura cerebrospinal fluid flows out, the stream being increased with each expiration. Absence of pulsation of the brain points to abscess or tumor, and a livid color indicates subcortical growth. An old laceration is brownish. If the brain bulges through the opening, it means increased pressure (tumor, abscess, effusion into the ventricles, etc.). After opening the dura employ no antiseptics, especially when the surgeon intends using electricity to locate a center. Irrigate only with warm salt solution. In operating for tumor the dura is opened and in some cases the brain is incised. The tumor is turned out by the finger, or, if this is impossible, by the dry dissector, the scissors, the dull knife, or the sharp spoon. If the entire tumor cannot be removed, it is sometimes proper to take away as much as possible. The removal of a portion often retards the growth of the remainder, and the trephining, by lessening cerebral pressure, relieves the symptoms and prolongs life. After removing a tumor arrest distinct points of bleeding with the ligature alone or the ligature passed around the vessel by means of a needle. Pack the tumor cavity with gauze and bring the

end of the strand out of the wound. Stitch the dura with silk and suture the scalp with silkworm-gut. In electrifying the brain faradism is employed of a strength about sufficient to move the fibers of the exposed temporal muscle. The best electrode is that of Cushing (Fig. 475). It is a "glass unipolar electrode carrying a fine platinum wire core, coiled into a spiral at the end" (Cushing, in "Keen's Surgery," vol. iii). The other pole is attached to an extremity "preferably on the homolateral side." During the electric test the



Fig. 473.—Combined osteoplastic operamion. Second step. Bone flap turned lown.



Fig. 474.—Combined osteoplastic operation. Third step. Showing exposure of brain by removal of dural flap.

atient must not be deeply anesthetized. A careful observer watches the suscular movements. If, for instance, the surgeon wishes to remove the numb center, he moves the electrode from point to point until he obtains numb movements. The region is sliced away bit by bit until the center hich is responsible for the conclusive movements is removed. It will be numb impossible to remove only the thumb center. Adjacent centers are sure





475.—Showing terminal and connection of Cushing's electrode (\$\frac{1}{4}\$ natural size). Instrument should be 16 inches or more in length.

be more or less damaged, and a certain amount of paralysis follows the Peration. If we wish to tap the ventricles, Keen directs the trephine opening be one and one-fourth inches behind the external auditory meatus and the same distance above the base-line of Reid (Fig. 476, a). A grooved director or metal tube is passed into the brain in the direction of a point "two and one-half to three inches above the opposite meatus." The normal ventricle will be entered at a depth of two to two and one-fourth inches, but the dilated ventricle will be entered sooner. The moment of entry is marked by lessened

resistance and a flow of cerebrospinal fluid. Drainage can be main by introducing a rubber tube. This operation has been employed in a cephalus. Kocher punctures the ventricle 2½ cm. from the midline and in front of the fissure of Rolandi. After an aseptic cerebral operation, as a do not drain unless hemorrhage has been considerable. In many case trephining replace the bone, but not when the bone is diseased, is into is very compact, or if it is desired to alter pressure. The dura is sutured continuous suture of silk or catgut; the scalp is sutured by interrupted worm-gut sutures.

Operation for Mastoid Suppuration.—The instruments require this operation are a scalpel, a gouge, a chisel, a mallet, curets, a predissector, dissecting and hemostatic forceps, and needles. Provide a bag to place under the neck. An incision is made one-quarter of an posterior to the auricle and down to the bone, and in the direction of



Fig. 476.—Opening the mastoid antrum and the lateral sinus; exposure of the tellobe and puncture of the descending horn of the lateral ventricle:  $a_i$  Temporosis scending cornu of lateral ventricle is i cm. deeper);  $b_i$  inner surface of period antrum;  $d_i$  lateral sinus (Kocher).

long axis of the mastoid. The bone is bared and examine a point in the line of the incision, which is on a level with the reference (Fig. 476, c). The bone will usually be found softened, and thus open the mastoid antrum. The bone-opening is of Macewen's suprameatal triangle, a space bounded by

of the zygoma, the posterior bony wall of the meatus, and an imaginary line joining the two. If the mastoid is opened in this triangle, the antrum is entered directly and there is no chance of wounding the lateral sinus. If, in the adult, pus is not found on opening the mastoid antrum, gouge downward and backward, but with great care, so as to avoid the lateral sinus. If there be any possibility of the existence of pus in the groove of the sinus, the sinus should be unhesitatingly exposed. After evacuating the pus from the mastoid gouge away bony septa, enlarge the opening between the mastoid and the middle ear with the gouge and remove the posterior bony wall of the meatus (avoid the facial nerve on the floor of the meatus), turn the head foward the side operated upon, and irrigate the mastoid with salt solution, dust with iodoform, pack with iodoform gauze for a few days, and then introduce a silver drainage-tube. Treat the causative ear disease. Sheild and Macewen operate on inveterate cases of mastoid disease as follows: A thick flap is raised behind the auricle, the flap including the orifice of any sinus and being "left attached by its stalk." The auricle is "detached forward and the soft parts over the mastoid are turned backward by horizontal incision." The "lining membrane of the canal is separated from the bone." The mastoid is opened and dead bone and caseous matter are removed, overhanging edges are chiseled down, and the posterior bony wall of the external auditory meatus is gouged away. The skin-flap is pushed into the cavity and is held In place with pads of gauze. The margins of the flap may be sutured, but this is not necessary. Macewen calls this procedure "papering" the cavity with skin.\*

If mastoid suppuration has established abscess in the temporo-sphenoidal lobe, trephine, one and a quarter inches behind and one and a quarter inches above the middle of the external meatus (Barker's point), and search for Pus as directed on page 821. If abscess of the cerebellum exists, trephine low the line of the lateral sinus. "The position of the lateral sinus is indicated by a line running horizontally outward from the occipital protuberance to within about an inch of the external auditory meatus, and thence downward to the mastoid process" (Owen's "Manual of Anatomy"). If indicated sinus-thrombosis exists, break into the lateral sinus (Fig. 476, d) the mastoid opening and proceed as directed on page 824.

Linear Craniotomy.—Instruments as for any brain operation, plus, however, several kinds of rongeur forceps. Make a large flap. Trephine the skull a finger's breadth from the sagittal suture, and the same distance back of the coronal suture. Rongeur the bone away in a line parallel with the sagittal suture and a safe distance from the longitudinal sinus, up to a point in front of the lambdoidal suture. Remove the pericranium which covered the bone excised. Insert the dural separator, or pass it along the margins. In some cases an additional portion of the bone is removed over the fissure of Rolando. Various suggestions have been made as to the direction and situation of bone-sections. Bleeding is arrested and the flap is closed without drainage.

Removal of Gasserian Ganglion.—(See page 781).

Operation for Infective Sinus-thrombosis.—(See page 824).

The Decompression Operation (Decompressive Trephining).—This operation is employed particularly in cases of inoperable brain tumor. It differs from palliative trephining in the fact that the dura is incised and an opening left to permit of bulging of the brain. The bulging relieves pressure. By Cushing's method we get a hernia of the brain, but not a fungus cerebri. I have followed Cushing's recommendation in tumors, and have used it in fractures of the base of the skull, and I believe it saves vision and life (in the latter condition it is done on both sides).

Cushing and Bordley have performed it in cases of uremia and improvement has followed ("Am. Jour. of Med. Sciences," Oct., 1908). They suggest that the operation be used in certain cases of renal disease when medical



Fig. 477.—Sketch of the intermusculotemporal field of operation, showing exposure with subtemporal bone defect partly made (Cushing in "Keen's Surgery").

treatment and lumbar puncture have failed to abate uremic symptoms, or when blindness is impending.

The effect of the operation in cases of brain tumor is sometimes extraordinary. Its most prominent benefit is in abolishing choked disk. It must not be done directly over a tumor, because the bulging tumor might become the seat of hemorrhage.

It is, of course, useless in relieving blindness, for blindness means atrophy, but it is often very valuable in *preventing* blindness. When choked disk exists operation should be done early even if there is good vision. If in advanced cases any sight remains, it should be performed. Now and then there is an unfavorable result, for instance, the development of retinal hemorrhages or the loss of vision, which was good previous to operation. (See DeSchweinitz and Hol-

loway on "Operative Treatment of Papillo-edema Dependent upon Increased Intracranial Tension," "Therapeutic Gazette," July 15, 1909.) The permanence of the relief to the choked disk is variable. It is not always permanent.

Cushing's subtemporal decompression is done upon the right side, as a rule, but in some cases on the left side. An objection to doing it on the left side is that the bulging of the left temporal lobe may cause word-deafness. A curved incision is made through the skin and subcutaneous tissue, the flap is turned down, the temporal fascia is incised in the direction of the muscle-fibers be-

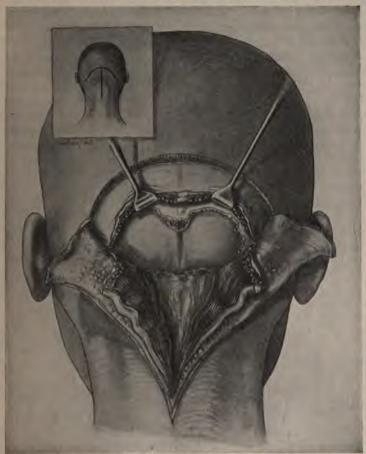


Fig. 478.—The suboccipital exposure showing opening partly made and Cushing's "cross-bow" incision (Cushing in "Keen's Surgery").

from the bone, the soft parts are retracted, the bone is opened as the surgeon prefers, and the opening is enlarged with a rongeur. The dura is opened and tadiating incisions are made through it toward the edges of the bone gap. The wound is closed by four layers of fine silk sutures.

Fig. 478 exhibits the exposure for suboccipital depression as done for subtentorial tumors. The same exposure is obtained in order to remove a cerebellar tumor.

## XXIV. SURGERY OF THE SPINE.

Congenital Deformities.—Myelocele or Rachischisis.—This condition is due to deficiency in the formation of the vertebral arches, the cord being rudimentary, the medullary plates having failed to coalesce, the central canal not having formed, and the endothelium which should line it being exposed. If the entire cord is involved, the condition is called amyelia or total rachischisis. If a part of the cord is involved, the condition is called partial rachischisis. In partial rachischisis a portion of skin is absent in the midline. At this area is a circular, dark-red focus surrounded by a very thin and glistening membrane which becomes continuous with the skin. A dimple at the upper part and a dimple at the lower part of the dark area indicates the situation of the central canal above and below. Victims of rachischisis are usually stillborn or at most live but a few days.

Spina Bifida.—This is a deformity similar to the one just discussed, but in it the cord is much more developed. The first accurate description of it was given by Tulpius in 1685. It is a congenital sac of fluid due to vertebral deficiency, permitting protrusion of the contents of the spinal canal in the median line. In this condition the cutaneous epiblast is adherent to the spinal exiblast, because structures from the mesoblast have failed to grow between. The laminæ or spines of one vertebra or of several vertebræ or of many vertebræ may be deficient, most frequently in the lumbosacral region. In very rare cases there is division of the vertebral bodies and the projection is foward and to the side. A case in which there are ununited laminæ but no protrusion is called spina bifida occulta. Sometimes there are two protrusions in one person. In spina bifida the dura does not cover the sac because it is cleft as well as the laminæ. There are three distinct varieties of spina bifida: 1. Meningocele. In this condition the dura is cleft (Hildebrand), there is a protrusion of the arachnoid, fluid gathers in the arachnoid meshes and "distends this so as to form one continuous cavity which is traversed by nerve-roots" (Henle, in "A System of Practical Surgery" by von Bergmann, Bruns, and von Mikulicz. Translated and edited by Wm. T. Bull and Carlton P. Flint). The cord is not in the sac. 2. Meningomyelocele (the commonest form) is a protrusion of arachnoid, the sac containing cerebrospinal fluid, nerves, and cord-substance. The cord may spread upon the sac-wall or it may pass through the sac and reënter the canal. A cutaneous dimple or furrow indicates that the cord is attached and hence is within the sac. 3. Syringomyelocele is great distention of the central canal, the sac-wall being formed of the thinned cord and the spinal membranes. A spina bifida varies in size from that of a walnut to that of an infant's head; it grows rapidly during the early weeks of life; it is usually sessile, but may present, where it joins the body, a definite constriction, or even a pedicle; the base of the sac is covered with healthy skin, and the fundus is covered only by thin epidermis or by the spinal membranes themselves. Pressure upon the tumor may diminish its size and increase the tension of the anterior fontanelle, and possibly cause convulsions or stupor, cyst is translucent, and the margins of the bony aperture are distinct. Crying, coughing, or pressure upon the anterior fontanelle makes the tumor

more tense. Spina bifida is apt to be associated with club-foot; with hydrocephalus, and with rectal or vesical paralysis. Spina bifida usually causes death (90 per cent. of cases die during the first year of life). A few meningoceles and a very few meningomyeloceles undergo spontaneous cure by growth of the vertebral arches constricting the neck of the sac. The sac may remain distended with fluid or may shrink. Syringomyelocele is invariably fatal. The cause of death may be rupture of the sac or marasmus. The x-rays show the bony gap. Spina bifida occulta is a cleft in the vertebral column without any protrusion of the cord or the membranes. In this condition there is usually a profuse growth of hair in the skin over the bony gap and the hairy condition may be much more wide-spread. In some cases the hair is present at birth; in others it appears at puberty. Trophic changes and deformities may exist in the lower extremities.

Treatment.-Very small protrusions which grow slowly and are covered with sound skin may be treated by the use of a compress and bandage, by an elastic bandage, or by applications of contractile collodion. It was formerly regarded as proper to tap and drain the sac. Injection was used by many. The skin being cleansed, the child was placed on its side and a little chloroform was given. A fine trocar was plunged obliquely in at the side of the sac through sound skin, little or no fluid being drawn off, and 3j of Morton's fluid injected (iodin, gr. x; iodid of potassium, gr. xxx; glycerin, 3j). The trocar was withdrawn and the puncture was sealed with a bit of gauze and iocloform collodion. The child was put to bed. If injection proved successful, the sac was found to shrink; if the injection failed, it was the custom to repeat it at intervals of from seven to ten days (Jacobson, White). Surgeons now prefer excision of the sac. Whenever possible the incision should be through healthy skin. If the sac contains nerves they should be placed within the canal. Bayer treats it as he would a hernia. Robson in some cases excises the entire sac. Operations upon children much under the age of five have an enormous mortality. Operations are comparatively safe when the child reaches the age of five. We should not operate if there is hydrocephalus or extensive paralysis, if the mass is very large and growing rapidly, or if there are other marked deformities. A ruptured sac should be operated on at once, otherwise death is practically certain. Operations for spina bifida have been done successfully immediately after birth (Lovett, in "Am. Jour. Orthop. Surg.," Oct., 1907).

Sacrococcygeal Tumors.—Dermoids external to the sacrum are occasionally seen in this region. Dermoids also arise between the rectum and sacrum. In the lower sacral or coccygeal region the cutaneous structures sometimes fail of complete coalescence and a post-anal dimple or sinus is the result. Such a sinus is lined with skin and its wall contains numerous glands and often hairs. It may inflame or suppurate. If it blocks up at the outlet, a form of dermoid develops. Teratomata, lipomata, and hydatid cysts may develop in the sacrococcygeal region.

Treatment.—Dermoids require extirpation. If a post-anal dimple causes no trouble, it is let alone; otherwise it is dissected out. It may or may not be possible to remove teratomata. Lipomata and hydatids are extirpated.

Anosacral Cysts.—These cysts develop between the sacrum and rectum and originate from remnants of the post-anal gut and neurenteric canal. Such cysts may be multilocular or unilocular. They can be detected by a finger in the rectum.

Treatment.—Some of these growths are removed after osteoplastic resection of a portion of the sacrum; others are removed by incising the rectal wall.

Tumors of the Spinal Cord.—Tumors may arise from the cellular tissue, fatty tissue, the nerve roots, the membranes of the cord, or from the vertebra (extramedullary tumors). They may arise with the cord (cord tumors

proper or intramedullary tumors).

Extramedullary Tumors.—Syphilomata, hydatid cysts, tuberculomata, and inflammatory masses or adhesions may compress the cord and produce symptoms indistinguishable from genuine tumor. Among extramedullar tumors are secondary carcinoma, sarcoma (primary or secondary), fibroma, myxoma, lipoma, chondroma, and neuroma. Dermoid sacral cysts may exist. Lipoma, fibroma, and certain cysts may be congenital.

Injury of the back sometimes seems to bear a causal relation to extra-

medullary tumors.

The symptoms are due to pressure upon nerve-roots and the cord.

Symptoms.—The most prominent symptoms are pain in the back and evidences of nerve-root irritation.

The early or irritative symptoms are pain and stiffness of the back, usually very severe and interfering with sleep, shooting pains in the area of the implicated nerve-roots, and sensory abnormalities in the same area. There may be hyperesthesia of a limited area. The area of distribution from one or two roots is involved in pain, sensory disturbance, and slight motor impairment. In some cases the nerve-roots of one side only exhibit irritation and the symptoms are strictly unilateral. In other cases the symptoms are bilateral, but are most marked on one side. In some cases the symptoms are symmetrically bilateral and indicate pressure upon the cord rather than upon nerve-roots. Muscular spasms may occur. There may be lateral curvature of the back, the concavity of the curve being on the side of the tumor. Sooner or later paralytic symptoms come on (motor and sensory paralysis). They may be due to pressure upon and destruction of nerve-roots or to compression of the cord. When anesthesia exists there may be a zone of hyperesthesia above its upper limit. As motor palsy develops from root compression the pain usually abates. The muscles undergo atrophy.

A tumor may, by cord pressure, produce the symptoms of compression-myelitis, locomotor ataxia, or myelitis. Contractures or paraplegia may arise from tumor. The location of the growth can be inferred by a study of the territory of paralysis and the zone of sensory disturbance. The tumor is always situated somewhat above the upper limit of anesthesia. In many cases the diagnosis is impossible. Gradually increasing painful paraplegia, with pain in the back and with hyperesthesia or anesthesia after a time appearing and ascending from the feet toward the trunk, points to tumor as a cause. The paralysis is usually spastic, but may be flaccid, or it may be spastic at first and become flaccid. In spastic paraplegia the reflexes are increased. In flaccid paraplegia they are decreased. In spastic paraplegia there are ankle clonus, the Babinski sign (extension of the great toe or all the toes when the sole of the foot is irritated), Gordon's paradoxical reflex (extension of the great toe or all the toes when pressure is made upon the deep calf muscles), and Oppenheim's reflex (extension of the great toe or all the toes when the handle of the percussion

hammer is drawn along the inner edge of the tibia so as to make pressure from above downward). Trophic lesions are apt to arise in the trajectory of nerve involvement. The sphincters are usually involved. Growths outside the membranes produce particularly pain and spasm; growths within the membranes produce especially motor paralysis and anesthesia. Symptoms that are unilateral were at first unilateral, or which are most marked on one side, are very significant.

Intramedullary Tumors.—These tumors develop in the substance of the cord. These are far less common than extramedullary growths. These growths are, as a rule, primary and solitary and do not produce symptoms of pressure until they attain the size of a hazel-nut. The most common tumors are glioma, sarcoma, and tuberculoma. Syphiloma occasionally arises. Most tumors in cord substance are small, but the glioma may involve practically the entire cord. A tumor is often for a time limited to one side of the cord, but later it presses upon and finally involves the opposite side. When the cord is pressed upon, degeneration occurs. In some cases a wrench or bruise of the back is supposed to be causal. Glioma may be congenital.

Symptoms.—They are at first, in most cases, very uncertain. In some

There is often pain in the back, but it is not nearly so severe as in extraedullary tumor. The most prominent symptom is a slow-developing motor
law lay. In some cases the palsy is at first unilateral, but later becomes bilateral.

itative root symptoms are absent (spasm and darting pain). Anesthesia or
peresthesia develop. The sphincters are involved and trophic disturbances
se. There may be spastic paraplegia or flaccid paraplegia. If the tumor
is in or presses upon the anterior corner there will be limited muscular atrophy.

berculoma produces the symptoms of transverse myelitis.

In glioma there are paresis and muscular atrophy. Although sensibility pain, heat, and cold are lost, sensibility to touch is preserved (sensory discipline)

Treatment of Tumors of the Cord.—If syphilis is suspected, give the partient a course of heroic doses of iodid of potassium, and administer mercury hypodermatically or by inunction. In a focal lesion not due to dissemination a known malignant growth, perform the operation of laminectomy to permit of exploration and possibly of removal. The laminæ of at least three vertebræ should be removed and the tumor is looked for distinctly above the upper level of the zone of anesthesia. It is not necessary for the patient to wear a spinal SUI Dport after the performance of laminectomy. McCosh truly says that operation for spinal-cord tumor is decidedly more hopeful than for brain tumor, because localization is much more accurate and removal can be effected with less permanent damage. Lloyd collected 51 operations: 10 per cent. died and 31 per cent. were actually cured or improved. Joseph Collins ("Med. Record," Dec. 6, 1902) collected 70 cases of spinal tumor, 30 of which were Operated upon. In 12 the operation was a success, that is, the pain disap-Peared and motor power returned; in 8 the operation was partly successful, that is, the pain disappeared and the motor power improved; in 10 the Operation failed and death occurred within a few weeks. If the tumor is found to be irremovable, McCosh suggests division of several nerve-roots to relieve the pain.

Acute osteomyelitis of the vertebræ is a rare disease; it may be associated with osteomyelitis of other bones, may be secondary to some distant suppurative focus, but may occur alone. Infections of the viscera not unusually accompany it. In many cases there is a history of trauma. Any part of a vertebra may suffer from it. This condition may follow cold, overexertion, or traumatism, and is more common in the first two decades of life than in elderly people. The process may be superficial, or it may involve the bone deeply and widely. Suppuration always occurs; sequestra generally form; and phlebitis is a dangerous complication. Any region of the spine may be attacked, but the lumbar region is particularly liable to invasion, next the dorsal, next the cervical. The sacral region is least often affected. The situation of the abscess varies with the situation of the disease. If the vertebral bodies are diseased, the pus passes forward (retropharyngeal, mediastinal, psoas, or pelvic abscess). If the vertebral arches suffer, the pus passes backward (lumbar or dorsal abscess). The membranes of the cord, the cord itself, the nerves, and the vertebral articulations are frequently involved in the process. Staphylococci, streptococci, or other pyogenic bacteria may be cultivated from the pus.

Symptoms.—The general symptoms are those of osteomyelitis. The local symptoms depend on the seat of disease. If the posterior portion of the column is diseased, there is a hard swelling, which, in the neck, is in the middle line; in the dorsal and lumbar regions, in the middle or to the side; and in the

sacral region, invariably to one side.

Rigidity of the spine always exists. If the vertebral bodies are affected, rigidity is noted, the spine is tender, and special symptoms appear, their nature dependent on the region affected (retropharyngeal abscess, etc.). Occasionally symptoms of meningomyelitis are noted. The constitutional symptoms of sepsis are marked. The condition is sudden in onset, and purulent collections diffuse widely and rapidly. These points enable the surgeon to make a diagnosis between osteomyelitis and Pott's disease. In osteomyelitis angular deformity very rarely arises, because the patient is obliged to be recumbent and because hyperostosis is taking place. The mertality, according to Hahn, is 60 per cent. Death may be due to pachymeningitis, pneumonia, empyema, retropharyngeal abscess, invasion of the cord, or amyloid disease (H. S. Warren, "Boston Med. and Surg. Jour.," May 7, 1903).

Treatment.—The patient is kept recumbent. His constitutional treatment is such as will combat sepsis (food, stimulants, etc.). A puriform area must be incised and disinfected. If bone denuded of periosteum is found, it is touched with a solution of chlorid of zinc or with the actual cautery. If a sequestrum exists, it is removed. A drainage-tube is inserted and dressings

are applied (Müller, Makins, Abbot, and Chipault).

Typhoid Spine.—It was pointed out by Gibney in 1889 that typhoid fever may leave as a legacy a painful, stiff, and weak back. Seventy-four cases of this condition have been reported (F. W. White, in "Jour. Am. Med. Assoc.," Feb. 13, 1908). The muscles of the back are found to be rigid and there is tenderness of one or more vertebræ. The pain may only be appreciated on motion, but in some cases there is aching even when the patient is at rest. The pain may be localized, may run into one or both thighs, or may be felt

in the abdomen. The symptoms arise at an uncertain period after the fever, develop rapidly, and are occasionally associated with transient episodes of fever. Kyphosis or lateral curvature may develop. (See L. W. Ely, "Medical Record," Dec. 20, 1902). Usually the patient is hysteric. The condition is due to osteitis and periosteitis, or chronic osteomyelitis. The prognosis is excellent.

Treatment.—The use of a plaster or leather jacket; counterirritation by the hot iron; later, massage and electricity.

Cervical Rib.—This condition was first described by Hunauld in 1743. The anterior limb of the transverse process of the seventh cervical vertebra, which has an independent center of ossification, may develop into a separate bone of large size, known as a cervical rib. Such a rib may form on one



Fig. 479.—Cervical ribs.

side or on both. It may scarcely reach beyond the transverse process, it may project well beyond the transverse process and have a free end, or it may constitute a complete rib which fuses anteriorly with the sternum, the cartilage of the first rib, or with a cervical rib of the opposite side.

Most instances described were found in the dead body, although Tillmanns collected 26 cases among the living (Carl Beck, in "Jour. Am. Med. Assoc.," June 17, 1905). Of late x-ray findings indicate that the condition is much more common than was formerly supposed. I have seen 4 cases. It may never produce any uneasiness, and hence may escape detection and seldom does produce trouble in youth. It may lead to damage of the subclavian artery (Keen's case developed aneurysm), or gangrene of the hand may result from bending or blocking of the vessel, or neuritis of the brachial plexus may arise from pressure. When sufficiently large to produce venous or vascular trouble,

a cervical rib can be felt and the pulsating artery over it is very distinct and higher than natural in the neck. The x-rays confirm the diagnosis. The treatment, when the rib is causing trouble, is excision of the rib with its periosteum (page 720). (See Kammerer, in "Annals of Surg.," Nov., 1901, on "The Diagnostic Difficulties.")

CONDENSED DIFFERENTIAL DIAGNOSIS TABLE OF SPINAL DISEASES AND CONDITIONS WITH WHICH THEY MAY BE CONFOUNDED.

	Scoliosis.	RACHITIC SPINE.	POTTS' DISEASE.	Hyper- esthetic Spine.	ARTHRITIS DEFOR- MANS.	TONTICOL- LIS, CON- GENITAL.	HIP DISEASE.
Age. Onset. Pain.	8 to 16. Insidious. In back.	4 to 6. Insidious. None.	4 to 6. Insidious. Referred to anterior abdomen.	16 to 20. Sudden. Severe in spine.	After 30. Insidious. In spine.	Any age. From birth. None.	4 to 6. Insidious. In knee.
History. Posture.	None. Free.	Rachitic. Excessively free.	TB. Guarded spine.	Trauma. Guarded.	None. Guarded spine.	From birth. Typic.	TB. Guarded hip.
Muscular rigidity.	None.	Free.	In spine.	In spine.	In spine.	In one di- rection only.	In hip in
Temperature. Local tender- ness.	None. None.	None. None.	ı degree. În spine.	Varies. Painful all over.	None. All over spine.	None.	r degree. In hip.
Night cries. Tendency to abscess.	Absent. None.	Absent. None.	Present. Probable.	Absent. None.	Absent. None.	None. None.	Present. Probable.
X-ray.	Character- istic de- formity.	Normal.	Focus in spine.	Normal.	Late bridges of bone.	Distortion of cervical spine.	Spine nor mal.
Hot-water test.	No tender- ness.	None.	Localized in spine.	Sensitive all over spine.	No necrosed sensitive- ness.	No tender-	No tender
General symp- toms.	Constant.	Constant.	Intermit- tent.	Constant.	Constant.	Constant	Intermit-

Spinal Curvatures.—There are four chief forms of spinal curvature:
(1) Lateral curvature (the scoliosis of the older surgeons); (2) posterior curvature (the excurvation, gibbosity, or kyphosis of the older surgeons); (3) anterior curvature (the lordosis of the older surgeons); and (4) angular curvature (the lordosis of the older surgeons);

1

Fig. 480.—Lateral dorsal curvature to the right, and compensatory lumbar curve to the left.

vature (from spinal caries). The normal spine has four curves: the cervical curve, the convexity of which is forward; the dorsal curve, the convexity of which is backward; the lumbar curve, which is convex anteriorly; and the pelvic curve, which is concave anteriorly. The dorsal and the pelvic curves, which are primary, are due to the formation of the cavities of the chest and pelvis, and depend upon the shape of the bones (Treves). The cervical and lumbar curves, which are compensatory, depend upon the shape of the intervertebral discs, and only appear after birth when the erect position is assumed.

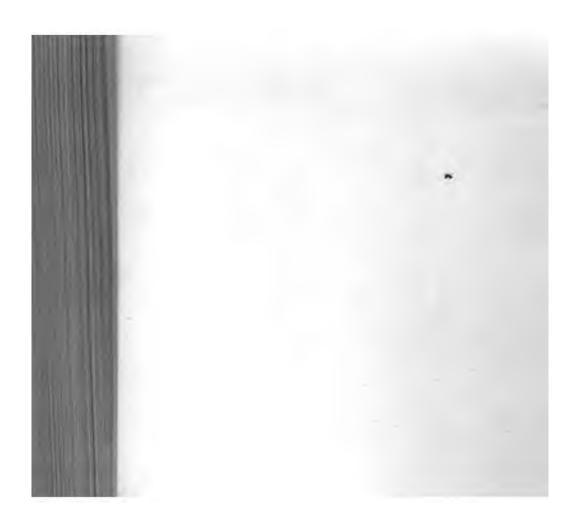
Scoliosis.—Scoliosis is a non-pathologic distortion of the spine characterized by rotation and lateral bending, hence the name, rotary lateral curvature (Plate 8). It is

functional or organic.

Functional scoliosis is caused by any prolonged alteration in the relationship normally existing between the axis of the shoulders and the axis of the hips.



Rotary lateral curvature of the spine.



Scoliosis 859

The etiologic factors depend upon the maintenance of faulty postures in occupations, especially during period of growth. School-life is especially influential in producing the condition because school furniture is adapted to the average requirements of a given class, and therefore a very small proportion of pupils are able to find desks and benches that are suitable. Properly furnished modern schools are supplied with desks and seats that are adjustable to each occupant. Gould ("The Ocular Factors in the Etiology of Spinal Curvature," H. Augustus Wilson, "New York Medical Journal," July 12, 1906) has directed attention to the errors of refraction that produce head tilting and thereby induce scoliosis. In adults, scoliosis is observable in blacksmiths, fencing masters, and waiters, where excessive use of the right arm produces an assymmetric posture of the body.

When functional scoliosis is not corrected or occurs in rachitic or indolent children, it results in organic or permanent changes in the contour of the bones posing the spinal column. Organic scoliosis may be congenital, caused by prenatal deficiencies or augmentations of the spinal column (see X-ray).

There is no pathology, but post-mortem examinations reveal a confirmation of Wolfe's law that prolonged alteration of the normal functions always results in changes of anatomic structures. In extreme cases the bones of the spinal column become extensively altered in shape, the ribs are altered in contour, and the thoracic and abdominal viscera are forced into unnatural positions and assume abnormal shapes, their functions often being materially altered.

Diagnosis.—The patient is usually taken to the physician because of apparent elevation of one shoulder, or because one hip is thought to be larger than its mate, or one mamma larger than the other. Dressmakers and corset makers are generally the first ones to direct attention to the faulty posture (as scoliosis occurs in eight girls to one boy). A patient suspected of having scoliosis should be nude at the time of inspection, as clothing hampers the normal action and tends to conceal the movements of the body. The accompanying diagnostic table (page 858) is a condensed comparative statement of the important features in diseases and conditions that may resemble scoliosis in some respects. It is only by carefully studying the symptom-complex that a definite decision can be reached. It is frequently observed that patients th mild types of functional scoliosis can sit or stand erect for a few minutes thereby deceive even a critical observer. The habitual posture, as well as rapidity with which the patient returns to the distorted position after temary voluntary correction, demand careful attention. Young children, when ded by parents or teachers, often temporarily assume an approach to a mal posture without actual correction. The ease with which their surnding joints yield in compensatory action is often overlooked. A patient h contracture of the pectoral muscles will elevate the shoulders into an Parent correction of stoop or round shoulders instead of throwing the ulders well back, a posture that is to them impossible.

Goldthwait has directed attention to forward curves of the scapula that often present in patients who are stoop-shouldered and has devised operation for its correction.

In the same way, a patient who has preternatural contracture of the hamg tendons, either unilateral or bilateral, will often conceal that condition by bending the knee or knees enough to permit the pelvis and trunk to bend forward.

Treatment consists especially of removing the cause. If the eyes produce head-tilting, proper refraction will be necessary. Adenoids should be removed. The clothing should be regulated to avoid constriction and the shoulder straps should fit close to the neck and not be allowed to slip on to the shoulder-joint.

Contractures of the pectoral muscles should be stretched by corrective manipulations. Hamstring contracture should be removed by corrective manipulation. Hoke ("A Study of a Case of Lateral Curvature of the Spine: A Report on an Operation for the Deformity," "American Jour. Ortho. Surg.," vol. 1, November, 1903, p. 169) has devised an operation of rib resection for cosmetic purposes. Every effort should be made to prevent the occurrence of scoliosis. The successful treatment of scoliosis depends on preventing its progress. It is essential that it should be fully understood that braces of any kind, as corsets and constricting clothing, are not only useless and irrational, but positively harmful. Especially injurious are the ready-made varieties of braces and spinal supports. Each individual patient requires careful study to determine the special characteristics that may be present. Remedial measures should be employed that meet the peculiar individual requirements of each case.

School gymnastics are generally more harmful than beneficial in cases of scoliosis. No one but a physician should prescribe the gymnastic work. The soft bones may be still further distorted by injudicious exercises.

The first requirement in the application of applied physical culture is to secure the hearty coöperation of the patient. Without such cooperation progress cannot be expected.

No gymnastic apparatus of any kind is required when the patient can be instructed in the proper methods of autoresistance. There are over four thousand movements of the body that may be employed in remedial physical culture. From this vast assortment those may be selected that are suitable to the peculiar conditions of the patient. At first the least tiresome forms are to be employed, and gradually and progressively others are resorted to until the patient presents a strong robust personality. Usually about a year is required for the purpose, as the progress must be essentially educational. Training in developing muscle action goes hand in hand with instruction in walking, in sitting, and in all the postures assumed by the human body in the various occupations of the patient.

In organic scoliosis, where the distortion is more or less of a permanent character, much can be accomplished in preventing the progress of the condition as well as in aiding correction by removing any rigidity that may be present. By increasing the flexibility we facilitate muscular development in much the same manner as in functional scoliosis.

When rigidity is present it must be considered in the same light as rigidity of any other joints. Its presence prevents muscular development. Manipulative measures are similar in effect to those employed in fibrous ankylosis of any joint, and are peculiar to the parts involved. In the majority of cases the force for manipulative correction must be applied through the interposition of the ribs, and the great danger of producing fractures of these structures should be realized. One familiar with the dangers as well as the technic will have

little difficulty in avoiding the former and applying the latter. In no instance is a layman warranted in undertaking the procedures that are necessary, and only a physician with experience in scoliosis will successfully carry such cases to a satisfactory termination.

In severe cases of organic scoliosis plaster-of-Paris jackets and other forms of fixation appliances are occasionally applied for definite purposes during the developmental stages. Such appliances should be made to order to fit the peculiarities of the patient and should never be the shop-kind that are extensively advertised. Much valuable time is often lost during the use of unmechanical and unsuitable apparatus, during which the bony changes become permanent and beyond repair.

Anteroposterior curvature (not from spinal caries or from hip-joint disease) is an increase of the normal anteroposterior curves. Increase of the dorsal curve is posterior curvature, kyphosis, or excurvation (Fig. 481, A); increase of the lumbar curve is anterior curvature, lordosis, or saddle-back (Fig. 481, B). Both lordosis and kyphosis are apt to be present. Scoliosis has nearly always some anteroposterior curvature associated with it. Lordosis is

apt to be compensatory, to prevent the center of gravity going too far forward. Lordosis is found in pregnant women and in very fat men. In an old man kyphosis arises from flattening out of the vertebral discs from pressure. Rheumatic gout may cause anteroposterior curvature. Anteroposterior curvature is often due to paralysis of the erector spinæ mass (from infantile paralysis). Pseudohypertrophic paralysis causes lordosis.

Symptoms and Treatment.—The symptoms of antero-Posterior curvature are as follows: the thorax is flattened or pigeon-breasted; the shoulder-blades are widely separated and the scapular angles project; the abdomen is protuberant; the patient complains of backache and

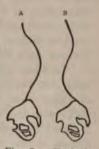


Fig. 481. - Kyphosis (A) and lordosis (B).

soon tires. A recent kyphosis disappears when the patient lies upon his stomach. The facts that the erector spinæ muscles are soft, and that Pain is absent on concussion transmitted to the back, separate kyphosis from caries. Lordosis is unmistakable. When the spine is movable, em-Ploy the same plan of treatment as in lateral curvature, suiting the gymmastics to the deformity (Roth). In painful kyphosis with partial ankylosis endeavor to make the ankylosis complete in order to prevent pain, obtaining this result by applying a plaster jacket which laces up and letting the Patient wear it for several years.

Angular curvature (spinal caries; spondylitis; Pott's disease) is usually to tuberculous caries of the vertebral bodies, and occurs particularly children who are predisposed to tuberculosis, but it may arise at any age. Any portion of the spinal column may be attacked. The dorsolumbar region most prone to suffer. The chief cause is tuberculosis, but syphilis and sec-Clary cancer of the vertebræ are occasional causes, and acute osteomyelitis is a very rare cause (page 856). Blows or strains may act as exciting causes.

Angular curvature may develop after an exanthematous fever.

The cancellous tissue of the anterior portion of the vertebral body becomes

primarily carious, or the inflammation begins in an intervertebral disc. (The changes of tuberculous osteitis have previously been set forth pages 220, 256, and 505.) The body of the vertebra and the vertebral disc are destroyed, and the process extends to adjacent vertebræ. The weight which rests upon the spinal column causes softened bone to crumble, compresses the diseased vertebræ and discs, and produces angular deformity (the anterior part of the column formed by the vertebral bodies is shortened, the posterior part is not, and hence the spines project). In some cases the disease is spontaneously arrested by organization of inflammatory products, and ankylosis (fibrous or bony) in deformity is nature's cure. In most cases, however, the disease spreads and caseous pus is formed, which, according to the point of formation and the route it takes, causes lumbar abscess, dorsal abscess, psoas abscess, or post-pharyngeal abscess (pages 161 and 162). In some cases the spinal cord is compressed, but in most cases it is not, and even when it is compressed, paraplegia is rare and is usually temporary. Compression of the cord may be caused by the displaced vertebræ or by inflammatory material or caseous matter between the bone and dura mater, but is most often due to pachymeningitis. Caries of the cervical region constitutes a more dangerous disease than caries of either the dorsal or the lumbar region (dangerous pressure occurs more easily). Death may be caused by exhaustion, sepsis, hemorrhage, amyloid disease, pneumonia, peritonitis, pleuritis, tuberculous dissemination, pressure upon the cord, or inflammation of the cord or its membranes.

Symptoms.—The sufferer from Pott's disease, if a child, grows tired easily, his disposition alters, he becomes moody and irritable, and complains of vague pains in many places, is disposed to lean, rest, or lie down, and walks with the back rigid, which produces a peculiar gait. A painful spot is found by pressing upon the spines. Faradism to the back causes pain. Spasm of the erector spinæ mass is detected (Hilton, Golding-Bird). It is not proper to seek to develop pain by jarring the back or by pressing the head downward. The posture of the child and the muscular rigidity prove the existence of inflammation, and to seek to develop pain by the methods referred to may do harm, and at best can only call attention to what is already known. Pain in the back, which is increased by motion, by pressure, and by vertebral jars, may be absent until late in the case. Distinct pain and tenderness in the back often mean abscess-formation. Neuralgic pains pass into distant parts (sciatica, intercostal neuralgia) and are often linked with muscular spasm. A chronic bilateral pain in the trunk or extremities is suggestive of Pott's disease. "Chronic bilateral belly-aches in children are almost diagnostic" (Jordan Lloyd). The pain of dorsal caries can be relieved by lifting the shoulders; the pain of cervical caries, by traction on the head. Cramp in the legs occurs in dorsal and in lumbar caries. The presence of the knuckle due to bending the spine at an acute angle is a very important sign of the disease. In many cases angular deformity appears late; in some cases it does not appear at all. An angular deformity is detected sooner in those regions where the normal curves are posterior than where the normal curves are anterior (Jordan Lloyd). The deformity appears early in the dorsal region, but late in the cervical and lumbar regions. In some rare cases lateral deformity occurs. Rigidity is an early sign of great importance. It is always present. Rigidity is manifest very early in cervical

caries, tolerably early in lumbar caries, late in dorsal caries. Lloyd gives the following practical rules to enable us to detect rigidity.\* In the cervical region: seat the patient in a chair and tell him to nod the head affirmatively. Stiffness in nodding points to occipito-atloid disease. Tell him to look far to the right and then far to the left. Stiffness of these motions suggests atlo-axoid disease. Tell him to place his shoulders against the back of the chair and carry his eyes back along the ceiling. Stiffness in this movement indicates disease below the second cervical vertebra. It is practically useless to examine the dorsal region of an adult for rigidity, but such an examination can be made in a child. Place the patient prone on an adult's lap, mark the tip of each spinous process with an anilin pencil, then make the child stand up straight on the floor, and observe if any of the pencil marks fail to come nearer together. If it is seen that two or more marks do not approach each other, there is rigidity which prevents approximation. To test for rigidity in the lumbar



Fig. 482.-Plaster-of-Paris jacket (Sayre).



Fig. 483.—Plaster-of-Paris jacket and jury-mast applied (Sayre).

region lay the naked patient prone upon a couch. Grasp the patient's ankles and raise the pelvis from the couch. If the lumbar spine is flexible, the pelvis can be lifted without raising the chest from the bed, and the maneuver deepens the hollow of the loin. If the lumbar spine is stiff, the maneuver lifts the trunk and produces no alteration in the vertical outline of the lumbar spines. If a child with Pott's disease is asked to pick up something from the ground, because of rigidity or pain on movement he will not bend the back, but will bend the knees or get upon the knees. Paralysis may exist, and it is due to pachymeningitis more often than to pressure from bone. Cervical caries causes dyspnea and torticollis, the head requiring support with the hands. Dysphagia indicates abscess. In adults the first signs of Pott's disease to attract attention are headache, backache, neuralgia, girdlepain, cramp, or even paralysis. In abscess due to caries of the dorsolumbar vertebræ the pus usually enters the psoas muscle and passes out of the pelvis below the junction of the middle and outer thirds of Poupart's ligament.

<sup>\*</sup> Birmingham Med. Review, April, 1897.

It may point here or may pass to the inner aspect of the thigh and point a little below the spot where a femoral hernia is met with if it exists. In a psoas abscess a mass is always felt in the iliac fossa above Poupart's ligament; in a hernia no such mass exists (J. T. Rugh). In sacral caries there is no deformity and frequently no pain. The diagnosis becomes apparent when bilateral abscess is detected in the buttocks or groins (Jordan Lloyd). If an abscess due to spinal caries opens spontaneously, healing will not occur,

but mixed infection takes place and death, as a rule, soon follows.

Treatment of Caries of the Spine.-When recent caries of the spine is active and affects a child; when it is accompanied by pain and fever; and when paralysis threatens, insist upon perfect rest. Place the child supine on a hard mattress, and, if possible, take it, while in a rolling bed, out of doors daily. Leeches, blisters, or the hot iron over the area of pain may do good. When the activity of the process abates, apply a fixation apparatus. In diseases at or near the vertebro-occipital articulation, as long as dyspnea persists, keep the patient supine with a small hard pillow under the nape of the neck (Hilton) and a sand-bag on each side of the head and neck. After several months mechanical support can be given by Furneaux Jordan's method. Jordan applies his support as follows: The patient lies on a flat, hard table, his arms are raised above his head, and traction is made upon the head by means of a pulley and a weight. Cotton pads are placed over the ears, the back of the neck, and the clavicles, and are held in place by a flannel bandage applied as a figure-of-eight on the head, neck, and chest. The flannel bandage is overlaid with plaster-of-Paris bandages.\* In disease of the cervical region below the axis, or of the dorsal region above the seventh vertebra, use Sayre's jury-mast (Fig. 483), or some other form of head support. Instead of the jury-mast a steel upright may be used to hold the head rigid. Sayre's appliance relieves the spine from the weight of the head and acts admirably. In most cases of dorsal and lumbar caries a steel, leather, or plaster jacket as a fixation apparatus must be employed. The best of all fixation apparatus is Sayre's plaster-of-Paris jacket applied while the patient is suspended (Fig. 482), or better, while the column is in hyperextension. The Sayre apparatus applied in this manner is used for the treatment of caries of the lumbar region and the lower half of the dorsal region. When all subjective signs cease, substitute for Sayre's jacket a felt or sole-leather jacket which laces down the front. Caries of the upper half of the dorsal region is often treated by a Sayre's jury-mast (Fig. 483); but if the jury-mast fails, it may be necessary to place the patient horizontally in "an open cuirass, fitted to the back from occiput to sacrum, and combined with pulley extension to the head and pelvis." †

During the course of caries of the spine have the patient eat fat-forming and nutritious food, insist on a plentiful supply of fresh air, and administer tonics and antituberculous drugs. Sea-air is very beneficial. When all active disease ceases and only angular curvature remains, use an apparatus to combine extension with mechanical support, the plaster jacket being generally employed.

Spinal abscesses are treated as indicated on pages 163, 164, and 707.

<sup>\*</sup> See "Children's Deformities," by Walter Pye. † Jordan Lloyd, in Birmingham Med. Review, April, 1897.

Paralysis in Pott's Disease.—Partial or complete motor and sensory paralysis may develop in the course of vertebral caries. It may be due to the pressure of tuberculous material or to pachymeningitis with thickening of the membrane. In only 2 per cent. of cases of paralysis is the paralysis due to the pressure of angled bone (Willard). The paralysis may come on gradually. There are weakness in walking or actual inability to walk, exaggerated reflexes, muscular rigidity, and impaired sensation in the legs, and loss of control of the bladder and rectum. Caries in the high dorsal region is more apt to result in paralysis than in any other region, because of the small size of the canal. Pressure in the cervical region is highly dangerous.

Treatment.—We must remember that angulation is the rare cause, tuberculous masses the common cause. Treatment for paralysis due to tuberculous masses is the full open-air treatment of tuberculosis, with rest, fixation, and progressive straightening of the spine. The patient is kept in bed (see Treatment of Tuberculosis, page 246) on a Bradford frame and with his head overextended (Willard). If after one year the condition is not notably improved, do laminectomy and clear away tuberculous masses. If angulation is the cause of the paralysis, we consider gradual correction, forcible correction, and laminectomy.

Gradual Correction of Angular Deformity.—Pressure is made upon the hump with the hand, and while the hand is thus held the weight of the body is allowed to bear upon it above and below. Something is perhaps gained and then plaster-of-Paris is applied, somewhat later a little more gain is obtained, and so on. This method is safer and more satisfactory than forcible correction.

Forcible correction of angular deformity is advocated by Chipault and Calot in cases of Pott's disease without abscess. Forcible correction is only used, if used at all, in angular deformity of the middle and lower part of the dorsal region. It is not used in the cervical, upper dorsal, or lumbar regions. Before it is used a skiagraph should be taken, to show if bony ankylosis exists or if there is an abscess. If there is an abscess, it must be treated surgically, and must heal before forcible correction is attempted. If bony ankylosis exists, it must not be broken down. Only recent cases are suited for this treatment, and only cases in which very few vertebræ are involved (Gabaert). The operation is unjustifiable if any organs are tuberculous, and if a patient is in very poor health. It is said by its advocates to be particularly indicated when the deformity interferes with respiration or digestion, or when there is paraplegia, especially if paraplegia is due to disease of the mid-dorsal region. The advocates of the operation claim that it does not injure the cord or its membranes. The operation is not entirely safe, and a number of deaths have been reported. Chloroform must not be given, as it seems to possess special dangers in this condition. Gabaert \* points out certain disasters which may follow forcible correction; they are: death during anesthesia; rupture of an abscess; subsequent paralysis of the legs and bladder; disseminated tuberculosis; and shock with convulsions and death. Forcible correction can be carried out as follows: the patient is anesthetized with ether and is placed face down; one assistant holds the feet, another the head, another supports the abdomen, and another the pelvis. While strong traction is made on the head and feet the surgeon

makes *forcible* pressure on the projection. After the correction of the deformity a plaster-of-Paris support is applied so as to include the neck, trunk, and pelvis, the site of the gibbosity being left exposed in order to avoid ulceration. A plaster-of Paris support is used for at least six months. After forcible correction a large gap exists, and this does not fill up with bone, but with dense fibrous tissue, and in some cases the spines and laminæ ankylose. When the support is first removed, there is usually a reappearance of the deformity to some degree. In some cases Cabot resects the spines and laminæ of the diseased vertebræ, and performs osteotomy of the ankylosed vertebral bodies.\* Personally I do not believe in forcible correction and I do believe that the alleged dangers are real dangers and that the operation is unsafe.

Laminectomy is warmly advocated by some surgeons for paraplegia from spinal caries. This operation is rarely necessary, but in some few cases is imperatively demanded. Many cases recover from paraplegia without operation—operation in these cases has a very heavy mortality (25 per cent.); and many are not benefited at all by it. If degeneration of tracts in the cord has occurred, operation cannot help the paralysis. Nevertheless, in some cases laminectomy has certainly cured palsy and saved life.

Laminectomy should not be undertaken until treatment by rest and fixation and extension has been applied for at least one year. Laminectomy may become necessary in cervical caries to prevent asphyxia. The operation enables the surgeon to remove masses of inflammatory material which make pressure on the cord, and also to free the cord from pressure due to angulation. The dura should not be opened unless there is evidently trouble beneath it, in which case it is incised and any tuberculous area removed, the dura being subsequently sutured. Ménard removes the transverse processes of the diseased vertebræ and the heads and necks of the associated ribs in order to give the surgeon access to diseased vertebral bodies.

Spondylitis Deformans (Bechterew's Disease).—This is the name usually applied to osteoarthritis of the spine (page 650). In this disease osteophytic formation takes place at the vertebral borders, and the vertebra become ankylosed. The vertebral bodies, as a rule, are most affected by the disease, but any portion of a vertebra may be attacked, and often the heads

of the ribs are anchored to the spine by bone.

The disease may begin in infancy, childhood, youth, adult life, or old age. Symptoms.—There are decided and persistent pain and tenderness of the spine, and occasionally evidence of pressure on the nerve-roots. Early in the case deformity is apt to occur, because at this period there is inflammatory softening.† The deformity is not angular, but is usually a total kyphosis, the column being bent forward from above and made into a single curve. Lateral curvature may occur. In many advanced cases and in some comparatively recent cases the spine becomes rigid and ankylosed, and when it does, there may be evidences of irritation of the posterior nerve-roots. In this condition there is rigidity of part or of the entire spine, other joints escaping. If the entire spine is involved, there is rigid cervico-dorsal kyphosis, a condition which causes the neck to stick forward and the head to appear as if forcibly driven down between the shoulders. If the entire spine is involved, the lumbar spine is rigid and the normal lumbar curve dis-

<sup>\*</sup>F. Cabot, in Archiv Prov. de Chirurgie, Feb., 1897. †J. Jackson Clarke's book on "Orthopedic Surgery."

appears. As a consequence the patient stands in an unnatural attitude, the hips and knees being partly flexed, and the legs and feet being in a condition of external rotation. In Bechterew's disease there are compression of the posterior nerve-roots, severe pain, muscular atrophy, and ascending degeneration of the cord. What Marie calls spondylitis rhizomelique is said by Osler to be a form of arthritis deformans. There is rigidity of the spine, shoulders, and hips, but no nervous lesions, as in Bechterew's disease.

Treatment.—Cure is impossible, but amelioration can be obtained.

The local and constitutional treatment is as for osteo-arthritis in any region (page 652). If curvature begins, a mechanical support must be applied.

Injuries of spinal ligaments and muscles, which may complicate serious injuries or may exist alone, are caused by wrenches, twists, and violent muscular efforts (as in lifting). Railway accidents may be responsible for these sprains and strains. The injury is called "railway spine" when

it is caused by a railway accident.

Symptoms.-Injuries of the back, even without cord-injury, are frequently linked with very deceptive nervous symptoms. Symptoms are often Severe, but are usually temporary. In some few cases the symptoms are Persistent. Secondary disease of the cord is extremely rare. Any region may be affected, but the lumbar is most usually injured, and the entire spine may suffer. The three marked symptoms are pain, tenderness, and stiffness of the back. At the time of injury, and for a while after, there is often marked shock, and hysterical excitement is occasionally observed. The cardinal Symptoms may arise very soon, but may not become severe for a day or two. The pain is not acute when at rest, but becomes acute on movement.\* The pain is felt in the back, and sometimes darts into the extremities. The muscles of the back are rigid, the spasm being due to pain. The patient is very careful not to twist or bend the spine, because to do so increases Pain. In a one-sided injury the rigidity is unilateral, and this symptom cannot be simulated. Often, but by no means always, the region of the back is swollen and the skin is discolored. The tenderness is not of the skin, but of the muscles. Firm pressure on a spot of real tenderness causes rapid pulse (Mannkopff). The vertebral spines are regular and are not mobile. There is no distant paralysis or hyperesthesia unless the cord is damaged (though in some rare cases the bladder and the rectum are paralyzed when no cord-lesion can be detected, and hyperesthesia may exist over the spines). Moullin tells us that the extremities feel weak because they are deprived of proper support on account of the immobility of the muscles of the back. For the same reason the action of the abdominal muscles is interfered with, and the power of micturition and of defecation is impaired (there are constipation and difficulty in emptying the bladder).

The treatment of recent injuries comprises rest, the application of an ice-bag, and leeching over the painful area. After a day or two hot fomentations, tincture of iodin, compression by adhesive strips, and inunctions of ichthyol and lanolin are used; and, later still, massage, douches, and frictions with a stimulating liniment are employed. Phenacetin helps to relieve pain,

though in some cases opium is necessary.

<sup>\*</sup> Moullin on "Sprains."

Traumatic neurasthenia is apt to arise after the *immediate* effects of the accident subside. In this condition the patient grows tired easily and complains of pains and aches in the back and loins, interfering with or preventing work; paresthesia and numbness exist in the extremities; in many cases sexual intercourse is impossible because of premature ejaculation or of incapacity for erection; there are dyspepsia, eye-strain, insomnia, loss of memory, rapid and irregular pulse, cardiac palpitation, and mental depression or confusion. The reflexes are usually exaggerated, but they can be exhausted more easily than can the exaggerated reflexes of organic cord disease (because of irritable weakness). Some rigidity and tenderness exist in the back, and the skin over this region is often hyperesthetic. Attacks of retention of urine may occur. Hypochondriasis is not unusual.

Treatment of Traumatic Neurasthenia.—Employ rest, tonics, massage, douches, and frictions to the back. Secure sleep, and endeavor to bring about a gain in weight. If sexual incapacity or seminal emissions worry

the patient, dilate the urethra with steel sounds.

Traumatic hysteria develops only in those predisposed by a neuropathic hereditary tendency; traumatic neurasthenia may arise in any one. In the firstnamed disease the accident is only the exciting cause; in the second disorder it is the cause. Many cases of so-called "railway spine" are really examples of traumatic hysteria. Traumatic hysteria and neurasthenia may be associated. Neurasthenia is a condition of exhaustion associated with a number of chronic disorders; it forms a foundation on which hysteria is apt to build its structure. The structure of hysteria is made up of morbid impressionability, hyperesthesia of centers, lowered self-control, and sensitiveness of the peripheral nervous system. The accident plays a double part in producing traumatic hysteria-first, by its effect on the mind (psychical traumatism); second, by its effect on the body, which anchors the attention to one point. An area of pain or stiffness often serves as an autosuggestion which undergoes morbid magnification when viewed through the distorting medium of hysteria. Erichsen taught that the symptoms of what he named "railway spine" arose from inflammation of the cord and its membranes, a view now abandoned. A blow given to a hysterical person causes a feeling of numbness, and thus negative sensation from local shock may establish the idea of paralysis, or traumatism, acting as a suggestion, may inhibit motor representations and destroy the normal ideas of motion and feeling (Charcot and Pitre). Terror always causes a feeling of loss of power in the legs, and the terror of the accident may thus develop the idea of paraplegia. The site of a traumatism may localize symptoms; for instance, a blow upon the eye may cause amaurosis or blepharospasm. It is important to remember Charcot's saying that a hysteria long latent and unrecognized may be awakened into obvious activity by a blow or an accident. Pitre shows the same to be true of epilepsy. A not unusual lesion is hysterical traumatic monoplegia, not coming on at once after the accident, but usually some days afterward, and presenting flaccid muscles, the electrical reactions and reflexes remaining normal, but the muscular sense being lost (Pitre). The muscles usually waste. The skin of the paralyzed limb is anesthetic or analgesic. There may be anesthesia limited to a limb, hemianesthesia, or general anesthesia.\* Hysterical paralysis is usually associated with the

<sup>\*</sup> J. Mitchell Clarke, in Brain.

pharyngeal anesthesia, convulsive seizures, and hysterogenic zones (Clarke and Pitre). The permanent stigmata may be latent. Hysteric phenomena lack regularity of evolution, and they may be produced, altered, or abolished by mental influences or by physical forces which produce no effect on organic disease. In most hysteric conditions the general health is not profoundly impaired.\* In making a diagnosis of hysteria we must be most careful to exclude both malignant disease and imposture, because hysteria is a sort of diagnostic waste-basket into which we cast most things which we fail to understand. Babinsky proposes that we should call phenomena hysteric only when they can be produced or can be cured by suggestion ("Brit. Med. Jour.," Jan. 23, 1909, p. 234).

Treatment.—By moral means chiefly. Gain the confidence of the patient. Suggestion is of great value. In many cases separation from family and friends is necessary and isolation is desirable. The Weir Mitchell rest-cure is often the best plan of treatment, and all its details should be carried out faithfully.

Malingering.—Persons often pretend to suffer from maladies of the spinal cord or column as a result of accident, which diseases do not exist in them. Some get well upon the rendering of a favorable verdict by a jury (litigation backs). In any case always examine carefully, so as to be able to exclude malingering. Note the patient's behavior and motions when his attention is diverted from his disease. Meningomyelitis can be excluded if there be no spasm, paralysis, hyperesthesia, paresthesia, or anesthesia at a distance (A. Pearce Gould). If pain has lasted for months; if pressure downward upon the head or shoulders does not increase pain; if the vertebræ are movable and there is no angular displacement, exclude caries. Gould states that when there are wasted muscles, when moderate spine movement is painless, but effort in bringing the body erect causes pain in the erector spinæ region, the trouble is a strain of the erector spinæ muscle. If the muscle is not wasted and the pain is in bending forward rather than in straightening up, the vertebral ligaments are the seat of trouble. Unilateral spasm cannot be simulated. The administration of ether may dispose of a pretended paralysis, the patient moving the suspected extremity while drunk from the anesthetic.

Concussion of the Spinal Cord.—This term has no definite pathological meaning. It is probable that the condition is one of laceration of capillaries and of cord-substance.

The symptoms are shock, intense pallor, nausea, often vomiting, and sometimes syncope. With this condition special symptoms may be linked—as temporary paralysis, a girdle-sensation, numbness and loss of power in the limbs, hiccough, torticollis, coarse tremors, pains in the back and limbs, areas of anesthesia and analgesia—depending on the portion of cord lacerated.

Treatment.—The treatment in concussion of the spinal cord is the same as that for sprains. Traumatic neurasthenia and hysteria or organic cord-disease may follow this injury.

Contusion of the spinal cord may arise from a blow or a sprain, but it is usually due to extreme flexion of the spine. It causes hemorrhage into the gray matter of the cord (hematomyelia). The symptoms are motor and sensory palsy and diminished reflexes. Some cases recover, but others end in myelitis.

<sup>\*</sup> Read the works of Thorburn and Pitre.

Wounds of the spinal cord are rare and are usually fatal. A knife is sometimes thrust in between the occiput and atlas. Wounds above the origin of the phrenic nerves cause almost instant death. Gunshot-wounds are the most usual form, the cord being damaged by the bullet and by bone-fragments.

In the American Civil War gunshot injuries of the cord were very rare (\frac{1}{2} of 1 per cent. of all wounds), but at the present day in war they represent more than \frac{1}{2} of 1 per cent. of all wounds, the increase in frequency being due to the increased penetrating power of the modern military bullet (Surgeon-General Robert M. O'Reilly, in "Keen's Surgery," vol. iv). The mortality is about 60 per cent.

A revolver bullet or a small-caliber bullet fired at long range may produce vertebral fracture without cord injury and any bullet may fracture a process of a vertebra without cord injury. If the laminæ are fractured the cord is almost sure to be injured. The cord may be concussed, lacerated, or cut across by bone or bullet, or compressed by bone or blood. The bullet may lodge or may perforate.

Treatment.—In a suspected wound of the cord do an exploratory laminectomy, arrest hemorrhage, and if the cord is divided, suture it. If a bullet is

lodged, remove it.

Compression of the spinal cord may be due to blood or to inflammatory exudate, as well as to displaced bone (page 872). Compression from blood may be due to extramedullary hemorrhage or to intramedullary hemorrhage. Extramedullary hemorrhage causes sudden pain in the back, the pain radiating from compressed nerve-roots; hyperesthesia and paresthesia in the area of the radiated pain; spasm of vertebral muscles supplied by the compressed nerves, sometimes of muscles whose nervous supply is below the lesion; tremors; convulsions; retention of urine; paralytic symptoms following the signs of irritation, but no absolute paralysis (Mills). A girdle-sensation is usual. Intramedullary hemorrhage causes pain, a girdle-sensation, abolition of reflexes, and paralysis. Spasms, rigidity, and paralysis come on early. Bedsores may form, and retention of urine and incontinence of feces may be observed. Paralysis from hemorrhage is rapidly progressive from below upward (crawling paralysis).

Treatment.—If paralysis from spinal-cord bleeding extends rapidly and life is endangered through the probable involvement of a vital center, perform a laminectomy, remove the clot, and arrest the hemorrhage. It is wise always to open the dura and inspect the cord. Extramedullary hemorrhage may be arrested by sutures or by packing. Intramedullary hemorrhage may be arrested by suture-ligatures or by packing. If an extramedullary clot is extensive, it is proper to make a second laminectomy near the lower end of the spinal column in order to permit the surgeon to wash it out thoroughly. The dura must be sutured and drainage is to be employed. If there is paraplegia, complete anesthesia of the paralyzed parts, and entire abolition of the deep reflexes, operation is probably useless, but it is justifiable to try it because of a possibility that the cord is not completely divided. In some cases with persistent paraplegia the operation should be undertaken. If operation is not undertaken, have the patient lie upon his side, apply a spinal ice-bag, and give morphin hypodermatically. If hemorrhage

continues in the cord and if the patient be plethoric, perform venesection.

To promote absorption of the clot and exudate give a combination of carbo-

nate and acetate of ammonium, order pilocarpin, and employ spinal galvanism and not douches.

Fractures and dislocations of the spine are very rare. The spinal regions most liable to injury are the atlo-axial, the cervicodorsal, and the dorsolumbar (Treves). A vertebra may be fractured alone, dislocation without fracture, except in the upper cervical region, very rarely occurs. These two lesions, dislocation and fracture, are so often associated that the term fract zere-dislocation is used by many surgeons to include them both. The causes of fracture and dislocation are direct force (seldom) and indirect violence (commonly). In fracture by direct force the laminæ and spinous processes are most apt to suffer. In most cases the fragments are not greatly displaced. A fracture by indirect force may result - from a fall on the shoulders, from a weight falling on the shoulders, or from a fall on the buttocks. Forced flexion or overextension is the commonest cause. In fractures from indirect force the cord generally suffers. In some cases the displacement of the vertebræ lacerates the cord, the vertebræ return into place, and no deformity is detectable. Fracture-dislocation from direct force may occur at any part of the column, and in this accident the posterior vertebral segments are driven together, and the cord, as a rule, escapes injury. Fracture-dislocations from indirect force most commonly happen in the dorsolumbar region, but are met with in the cervical and dorsal regions. In the cervical region reduction can usually



Fig. 484.—Spine sawed. Fracture of the spinous processes of the seventh cervical and first and second dorsal vertebræ. Fracture of the bodies of the fifth, sixth, and seventh cervical vertebræ with displacement backward of the upper fragment. Total crush of the cord. The section passes a little to one side of the cord, which is seen in place, and the staining of the cord by hemorrhage into its substance shows plainly through the membranes even in photograph. The spinous processes of the second and third dorsal vertebræ were found fractured at the operation, and were removed (Thomas).

be secured, but in the lumbar region reduction is impossible.

Symptoms.-In fracture-dislocation great displacement is unusual, but

some is almost always recognizable (irregularity of the spines or angular deformity). There are pain (which is increased by motion), tenderness, ecchymosis, and motor and sensory paralysis. Priapism, cystitis, and retention of urine often occur. Horsley has pointed out that in many cases paralysis passes away only to recur subsequently, the recurrence being due to edema of the cord. In some cases of spinal injury there is temporary paralysis due to shock. Persistent paralysis may be due to laceration of the cord, division of the cord, or compression of the cord by bone, blood-clot (Fig. 485), or products of inflammation. The extent of paralysis depends on the

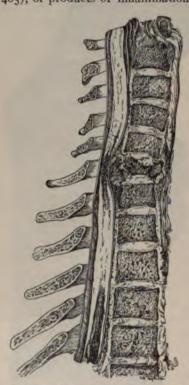


Fig. 485.—Fracture of the cervical spine, cord compressed by bone and blood. Hemorrhage into the cord at the seat of the lesion and below the lesion (Warren Museum). (From Scudder's "Treatment of Fractures." Drawn by Byrnes.)

seat of the cord injury. We must always try and decide if the spinal cord is completely divided or hopelessly crushed (Fig. 484). When the symptoms are not immediate in onset; when all the muscles below the seat of injury are not completely paralyzed; when there is some retention of sensation; when reflexes are present and muscular rigidity exists, we may be sure that the cord is not completely divided. When the cord is completely divided the symptoms are immediate, there are absolute flaccid motor paralysis and complete sensory paralysis (loss of appreciation of pain, touch, and temperature). The line of anesthesia is definite and



Fig. 486.—Lesion of spine between fifth and sixth cervical vertebræ. Note position of arms, due to paralysis of subscapularis. Brachialis anticus, supinator longus, and deltoid muscles intact. Elbow flexed, shoulders abducted and rotated outward (after Thorburn).

suddenly terminates (Walton). The bladder and rectum are paralyzed and there may be priapism. All the reflexes, superficial and deep, except perhaps the plantar, have disappeared. There is no pain, there are no muscular spasms, there is vasomotor paralysis with sweating of the paralyzed parts, and the symptoms persist and do not vary (J. J. Thomas, in "Boston City Hospital Med. and Surg. Reports"). There is usually tympanites (Walton). If this latter symptom-group is due to shock, it will usually be temporary, but occasionally, even when so caused, it persists some considerable time.

It is also probable that concussion of the cord may in some cases simulate complete division. As Walton says, no symptoms prove a hopeless crush of the cord: it is the persistence of the symptoms which does prove it ("Jour. Nervous and Mental Diseases," Jan., 1902); I would add the unchanging persistence of the symptoms proves it.

A. J. McCosh ("Jour. Amer. Med. Assoc.," Aug. 31 and Sept. 7, 1901) points out that definite pressure is indicated by marked symptoms and absence of reflexes. When there is not definite pressure, the symptoms are irregular; there is incomplete palsy, or muscles of the same group show different degrees of paralysis; anesthesia is partial; signs of irritation are not distinct, and there are patches of hyperesthesia and zones of paresthesia. If in doubt, at the end of twelve hours perform an exploratory operation.

The prognosis depends on the amount of damage done to the cord. Fracture-dislocations in the cervical region produce obvious deformity, stiffness of the neck, and irregularity of the spines, and a displaced vertebra may occasionally be detected by a finger in the pharynx. Crepitus can rarely be detected unless a spinous process is fractured. The Röntgen rays aid diagnosis. The seat of cord injury may be determined by a study of

the palsy and other symptoms.

Fracture-dislocation of the atlas or axis usually causes instant death. When the displacement is only trivial, the patient may actually recover, but will probably die of secondary cord disease. Dr. N. I. Blackwood of the U.S. Navy records a case of fracture of the atlas and axis and forward dislocation of the occiput on the spinal column, life having been maintained for thirtyfour hours and forty minutes by artificial respiration, during which time laminectomy was performed on the third cervical vertebra ("Annals of Surgery," May, 1908). Lofton has recorded a case of recovery after dislocation of the anterior arch of the atlas on to the odontoid process ("N. Y. Med. Jour.," April 18, 1908). In injury of the third cervical vertebra the phrenic perve is involved, the diaphragm is paralyzed, and death soon occurs. In fracture-dislocation of the fifth cervical vertebra the subscapularis muscles are paralyzed, but the biceps, brachialis anticus, supinator longus, and deltoid escape, and the patient assumes a characteristic attitude (Fig. 486). In Jones' case of fracture of the fifth cervical vertebra no operation was performed, but the patient partly recovered and became able to walk, but with a spastic gait ("Lancet," Nov. 28, 1903). If the sixth cervical vertebra is dislocated, there is palsy of the muscles of the hand. In injuries below the sixth vertebra no muscle of the arm, forearm, or hand is paralyzed at first, although after some days paralysis may develop. Damage to the cord above the sixth cervical vertebra produces anesthesia of the body below the injury and of the entire upper extremity except the shoulder. In injury just above the upper level of the seventh cervical there are body-anesthesia and anesthesia of the outer surfaces of the arms and ulnar margins of the forearms and hands. In any cervical injury there are body-anesthesia and diaphragmatic respiration, and in cases without paralysis of the arms there is sure to be pain. Injuries of the dorsal spine can be accurately located. There is paralysis of motion and sensation up to, or almost up to, the seat of injury. The arms are not paralyzed. Very great pain in the legs occurs if the lumbar enlargement is involved. In injury of the twelfth dorsal or

upper lumbar vertebra there are paralysis of the bladder and rectum, an incom-

plete anesthesia, and a partial motor paralysis of the limbs.

Treatment of Fracture-dislocations.-When dislocation of the body of the vertebra obviously exists, the surgeon may attempt reduction by exten sion and rotation. The maneuver is very dangerous in the cervical region and, as deaths have happened, some eminent surgeons advise against reduc tion when the injury affects that region. Walton's plan for a unilateral cervica dislocation is as follows: Give the patient ether and hold him erect and sitting on a chair. The surgeon stands behind the patient and holds the head with both hands. The first motion is a slight degree of rotation to carry the dislocated process forward and "unlock" it. The head is then rocked toward the sound side and somewhat backward and finally the process is replaced by rotation. No force is used (Clopton, in "Interstate Med. Jour.," Jan. 1908. Quoted in General Surgery by John B. Murphy, 1909). After reducing a fracture-dislocation of the cervical region, place the patient in bed elevate the head of the bed a few inches, and immobilize the neck and head In fracture-dislocation of the dorsal or lumbar region the traditional plan is to straighten the spine, gently if possible, and to put the patient upon his back upon a water-bed or upon air-cushions. Empty the bladder every six hours with a soft catheter, which is kept strictly aseptic. Take ever precaution to prevent bed-sores. Some surgeons advocate reduction of the deformity by extension and counter-extension, and the application of a firmly fitting but removable jacket with the suspension collar (as used in Pott's disease). If this plan is employed, the head of the bed is raised and the collar is fastened to it. Every day extension is made gently-from the shoulders in dorsolumbar fracture and from the chin and occiput in cervical fractures Extension may be maintained permanently until cure. Surgeons have come rather slowly to a belief in laminectomy. One deterrent factor has been the high mortality: Lloyd collected the records of 159 operations and found that 59 patients died almost at once and 39 died later. Some employ purely expectant treatment in vertebral fractures. My own feeling is that when simply a spinous process or some other part is fractured, and there are no cord symptoms, we may treat the patient expectantly, following Burrell's advice, and fixing the patient in bed on a Bradford frame and having him carefully nursed and watched. Reduction by extension and counter-extension is dangerous and unjustifiable if there is marked kyphosis and it cord symptoms exist. I agree with Burrell that it should only be done it operation is refused, or if there are no cord symptoms and no marked kyphosis ("Annals of Surgery," Oct., 1905). If it is attempted it must be done slowly and as gently as possible because it may cause grave or even irreparable damage to the cord. I fear to delay, and, with Burrell, Lloyd, Walton, and others, operate when the patient recovers from shock, if there seems to be even a gleam of hope that operation may help him. To wait when pressure exists means that during every hour of delay the pressure is damaging the cord Another reason for operating is that we cannot know the condition of the cord without direct inspection. The operation to be performed is laminectomy. As before stated, this is to be done even if we suspect division or hopeless crush of the cord. In some cases, it is true, we may commit the error of operating when there is only concussion, but such a mistake is less grave than to fail to

operate when there is bone-pressure or hemorrhage. An objection filed by the neurologist against laminectomy is that portions of cord above and below the level of the fracture may be damaged (Fig. 485), but, as Lloyd says, this fact does not forbid operation, but renders it necessary to make a wider exploration than has been the custom. In many cases after prompt laminectomy we get some considerable improvement, and this improvement may be sufficient to enable a man to earn a living. It is true that statistics would indicate that late operations have been more successful than early ones, but these figures must be analyzed in the light of the knowledge that many of the fatalities after early operation would have occurred if no operation had been done, and some improvements after late operation would have occurred to as great or a greater degree after early operation. The prognosis of any operation, early or late, is never gratifying, and Thorburn feels no confidence in obtaining improvement except in injuries of the laminæ, hemorrhage, or injuries of the cauda equina, as he says laminectomy in the cervical region is followed by death, and laminectomy in the dorsal region, though not commonly fatal, is seldom followed by recovery of function. Our statistics of early laminectomy will show fewer deaths and fewer useless operations if we do not operate till shock abates. As Lloyd says ("Phil. Med. Jour.," Feb. 5, 1902): "It is therefore evident that if we operate immediately after the injury we will have failures that should not be charged against the operation itself, and, if possible, we should wait before operating until the question can be settled whether the patient will overcome the shock or will succumb directly to the effects of the injury." All surgeons operate for compound fracture, for hemorrhage, and for cases with marked bone-pressure. If early operation were not performed and if pachymeningitis arises, operation is called for.

My own convictions are that if symptoms are significant, we should explore, as soon as shock has passed away, even if we think it probable that the cord has been divided; and if it is found divided, it should be sutured. If in any case we are in doubt twelve hours after the injury as to whether or not pressure exists, we should explore. If soon after the accident we think pressure by bone exists, we should operate. If the case is improving, we should not operate even if there are pressure-signs, unless there is a chance that pressure is due to bone, in which case we should operate. As McCosh says, pressure by blood or inflammatory exudate may pass away; pressure by bone cannot. Even long after an injury laminectomy may be productive of some benefit.

The rather radical views set forth above regarding the advisability of operating even if the symptoms point to complete division of the cord arose largely from a knowledge of the well-known case operated upon by Stewart for total division of the cord. In a case of gunshot-wound of the dorsal spine treated at the Pennsylvania Hospital by Francis T. Stewart, and reported by Francis T. Stewart and Richard H. Harte ("Phila. Med. Jour.," June 7, 1902), an exploratory incision made three hours after the injury showed that the spinal cord was completely divided. There was a fracture of the laminæ of the seventh dorsal vertebra. The spines and laminæ of the seventh and eighth dorsal vertebræ were removed. The bullet-hole was recognizable in the membranes, and the bullet and some bone-fragments were removed.

When the dura was opened, the ends of the completely divided dorsal con were found to be three-quarters of an inch apart. Stewart freshened the ends and brought them together with two sutures of chromicized catgu In this case a considerable degree of restoration of function took place. the time of the operation, three hours after the injury, there were comple paralysis and absence of reflexes below the seat of injury; but sixteen month later the patient was able voluntarily to flex the toes, flex and extend the leg flex and extend the thighs, and, while sitting, lift an extended leg from the The movements of the lower extremity became more forcible who reinforced by contracting the muscles of the upper extremity while making them. The patient could stand with one hand resting on the back of a chair and could get herself from her bed to her chair by sliding. The bowels we under perfect control, and there was no incontinence of urine when she was awake, although there was occasionally some when she was asleep. The were occasional cramp-like pains in the lower limbs. The sense of touch temperature, pain, and position were perfect all over the previously parlyzed parts. Below the knee the localization of sensation was not so accu rate. There was a slight amount of muscular rigidity; and on each sid an ankle and patellar clonus, which was easily exhausted. When the so of the foot was tickled, the big toe flexed, the thigh abducted, and there was slight contraction of the anterior tibial, the hamstring, and the tensor vagin femoris muscles. There were no reactions of degeneration and no troph changes. There had never been any bed-sores. George Ryerson Fowle ("Annals of Surgery," Oct., 1905) operated on a gunshot-wound of th dorsal spine eleven days after the injury. He removed the laminæ of th tenth, eleventh, and twelfth dorsal vertebræ and found the cord divided, th bullet lying between the severed ends. A piece of dura one-eighth of an inch wid was intact. The bullet and blood-clot were removed. The cord was suture with three sutures of chromicized gut, which included the dura, and more suture were taken through the dura only. The ends of the cord were easily approx mated. The patient recovered from the operation. Twenty-six month later voluntary motion was found to be practically lost in the area below the injury, although when supported by the hands he could stand and whe in a frame could move a little by a swinging movement. He is able to te when his bowels or bladder are about to move, and, if furnished promptl with a utensil, does not soil himself. When asleep, he passes urine involun tarily. Both legs exhibit spastic rigidity, but there are no reactions of de generation. Patellar reflex on each side exaggerated. Ankle clonus is found on one side, but not on other. There is complete anesthesia of the affected area except in a region five inches in length on the outer side of the right thigh Touch is appreciated but not correctly localized. In connection with the fore going important cases we would note that Dr. Estes, of Bethlehem, has als operated upon a case of complete division of the spinal cord, in which suturin was followed by some restoration of function.

In the light of these positive reports we must ask ourselves if we have no been wrong in the view that the spinal cord cannot regenerate. If ther is even a chance that we have been wrong, we must reverse our former con servative treatment and follow a radical plan. The three cases strongly sug gest the possibility of some regeneration, but do not prove it. The cord may

have appeared to be completely divided and yet minute undivided bundles may have escaped recognition. Again, as Fowler suggests, there may be a nerve anastomosis through uninjured portion of the dura or between adjacent nerve-trunks which arise above and below the lesion. At my request Dr. Samuel Lloyd, of New York, kindly wrote me a personal communication setting forth his views on this important subject. They are as follows: "The question of the regeneration of the spinal cord after traumatism of the spine deserves careful consideration in all cases that are operated upon. Up to the present time, however, although a number of operators have reported improvement following suture of the spinal cord in these cases, a careful analysis does not substantiate the fact that that improvement is due to an actual regeneration. It is a recognized fact on the part of all who have had experience with the surgery of the spinal cord that in almost every instance a certain amount of improvement is noted during the first few months. This is probably due to the fact that at the time of the injury minute hemorrhages occur into the adjoining segments, and that pressure is also increased in those portions of the cord by the inflammatory exudate and edema. Within a short time after the injury these conditions improve, and there seems to be an improvement in function; but in every case of spinal suture yet reported the amount of improvement may be explained by these facts. In no instance has there been a complete recovery of function, but in every one there has remained more or less permanent disability. This, however, should not discourage attempts at spinal suture, and in every case operated upon the dura should be opened and the condition of the cord examined. In those cases where a complete destruction has occurred and where the extent of it is not over three-quarters of an inch, it may be possible to cut out the lacerated portions and coaptate the surfaces by a series of sutures placed in the dura. In all these cases the patient should be put up in a plaster retaining bandage in extreme extension, even the head being thrown back so as to relax as much as possible the tension on the line of suture. The operator should be very sure, however, that there are no undestroyed fibers traversing the lacerated area, for the destruction of these in case regeneration did not occur would increase the amount of paralysis." With the views of Lloyd I am in entire agreement, and in future I shall follow this plan, bearing in mind that it is often impossible to tell whether the Spinal cord is completely divided or seriously damaged without examining it, and it can be examined only by exploratory operation; therefore, if the serious Symptoms already indicated exist after shock has passed away, exploratory Operation should be performed; if pressure exists, it should be removed; and if the spinal cord is found to be completely divided, it should be sutured. is well to remember that Abbe's experiments have shown that there may be great difficulty in bringing the divided ends of the cord into apposition. order to effect this it may be necessary to resect a vertebra.

Operations on the Spine.—Operation for Spina Bifida.—A. W. yo Robson maintains\* that operation is not demanded when the sac is small size and is well protected by sound integument; that operation is proper when a large portion of the column is fissured, or when paraplegia or procephalus exists; that operation is advisable only in meningocele, in

<sup>\*</sup> Annals of Surgery, vol. xxii, No. 1.

cases in which the integument is thin and translucent, in cases in which the cord is flattened out or the nerves are fused. Robson has closed the osseous defect by transplanting periosteum.

Instruments Required.—Scalpels, dissecting and hemostatic forceps, scissors, mouse-toothed forceps, rongeur forceps, dural separator, Hagedorn

needles and needle-holders, silk, silkworm-gut or catgut.

Operation.—Surround the sac by elliptical incisions. Find the neck of the sac, and if it contains no visible nerves, ligate it and cut off the protrusion. Push the stump into the canal. Freshen the bone-margins and spring a piece of celluloid beneath them to close the gap (Park). Suture over the stump with small sutures of catgut.\*

Treves's Operation for Vertebral Caries .- (See page 707.)

Laminectomy.—The instruments required for laminectomy are Horsley's bone-cutter, dissecting, mouse-toothed, and hemostatic forceps; scalpels; bone-cutting forceps; rongeur forceps; a dry dissector; a periosteum-elevator; sequestrum forceps; small scissors, straight and curved on the flat; a chisel and mallet; retractors; blunt hooks; a probe; tenaculum forceps; a spoon-curet; a sand-pillow; fine needles, curved and straight, large needles, and a needle-holder.

In the operation of laminectomy the patient lies prone and a sand-pillow is placed under the lower ribs. Make a vertical incision over and down to the vertebral spines, the middle of the incision corresponding to the seat of injury or disease. The sides of the spinous processes and the lamine are cleared. The periosteum is incised in the angle between the laminar and spines, and is lifted away from the arches. The spinous processes are cut off close to their bases by means of the bone-cutter forceps, the laminæ are removed on each side with the same instrument or the rongeur, and the dura is exposed. In some cases of fracture fragments will be found on exposing the vertebra, or a blood-clot will be seen between the dura and the bone; in other cases the dura must be opened with scissors vertically in the middle line while it is grasped with mouse-toothed forceps. After reaching and removing the compressing cause, or after failing to find or remove it, it is best not to close the dura completely, because if we do so, cord pressure may result from hemorrhage. The dural wound is left open or is partly closed. I used to insert a drain of rubber tissue, but have given it up. Horsley shows that it is not necessary, and if we refrain from draining we lessen the tendency to headache, temporary pyrexia, and rapid pulse, which frequently follow laminectomy. The superficial parts are stitched with silkworm-gut and dressings are applied.

Puncture of the spinal meninges, or lumbar puncture, was devised by Quincke, and has been carefully tested by many surgeons. It is the operation for withdrawing cerebrospinal fluid from the subarachnoid space of the cord. It is employed as a means of diminishing cerebral pressure in hydrocephalus, cerebral tumor, uremia, and tuberculous meningitis, but in these cases it has proved of little or only of temporary therapeutic value. It may be of some service in cerebrospinal meningitis. The condition of a patient with a fracture of the base of the skull is sometimes temporarily improved by 一つす このすり あこりこのでかっ .

<sup>\*</sup> A full consideration of the various plans of operating will be found in an article by Marcy, in Annals of Surgery, March, 1895.

the operation. Pain is often temporarily relieved. In the performance of a brain operation the brain may bulge so that the dura cannot be sutured. Lumbar puncture makes suturing possible. Puncture is the preliminary step of spinal anesthesia. In some cases the examination of the fluid has been of great diagnostic value. The fluid is not only subjected to a naked-eye study, it is also studied microscopically and bacteriologically. If the fluid from the puncture gives no positive finding, the operation should be repeated (Lorgo). When a diagnostic tap is made we must know the appearance, nature, and pressure of the fluid normally.

Normally the fluid is clear, transparent, and alkaline under a pressure of from 40 to 60 millimeters of mercury (Dana), its specific gravity is from 1.006 to 1.008, and from 5 to 10 cc. will flow out at a tap. It contains a very few endothelial cells and leukocytes. In cases of increased tension it flows out more forcibly, rapidly, and profusely (brain tumor, hydrocephalus, meningitis, and some infectious conditions). When there is meningeal inflammation the specific gravity is increased. In apoplexy and other hemorrhages beneath the cerebral arachnoid, in fracture of the base of the skull, and in hemorrhage beneath the arachnoid of the cord, the fluid contains blood. Laceration of the brain tissue without subarachnoid or ventricular hemorrhage does not make the fluid bloody. The fluid is turbid in purulent meningitis of the cord or brain. Lumbar puncture is of great diagnostic use in the cerebral hemorrhage of the newborn and in some fractures of the base of the skull.

The chemical study of the fluid is sometimes of value.

In intracranial tumor, purulent meningitis, subarachnoid hemorrhage of the brain or cord, and apoplexy albumin is increased. The normal fluid contains a substance resembling or identical with glucose. This is often absent in meningitis and is increased in saccharine diabetes.

In uremia the chlorids are diminished.

Cytodiagnosis (a microscopic study of the cells of the fluid) may furnish useful information. Lymphocytosis suggests a tuberculous lesion rather than an acute meningeal inflammation. Lymphocytosis occurs also in syphilis of the brain and cord, locomotor ataxia, paresis, and uremia.

Bacteriologic study by cover-glass preparations or cultures may give im-Portant information. In over 75 per cent. of cases of tuberculous meningitis of the brain membranes the fluid contains bacilli. Stadelmann has reported 37 cases in which tubercle bacilli were found in the fluid.\* In tuberculous eningitis the fluid may or may not contain tubercle bacilli. In cerebrospinal meningitis the cerebrospinal fluid contains the meningococcus. In this disease bar puncture is unnecessary if the nasal mucus contains the diplococcus tracellularis. The operation of lumbar puncture is simple, and if done with per precautions, is harmless. The back should be carefully sterilized and rough asepsis must be preserved in every detail. The patient may lie on the t side with the left knee well drawn up, may lie prone, with a pillow under belly, or may sit in a chair, with the body bent forward. The site of the belly, of may sit in a char, which ethyl chlorid, but no general anesthetic required. A Pravaz syringe is employed. The needle, which should be inches in length, is guarded by the surgeon's index-finger and the point inserted 1 inch to the right of the median line and between the third

<sup>\*</sup> Berliner klinische Wochenschrift, July 8, 1895.

and fourth lumbar vertebræ. It is pointed upward and a little inward under a spinous process. In a child the needle enters the canal at a depth of from 2 to 3 centimeters; in an adult, at a depth of from 4 to 6 centimeters. The fluid is permitted to fall drop after drop into a sterile test-tube. In some cases but a few drops of fluid will be obtained; in other cases many cubic centimeters may be removed. It is not wise to draw for diagnostic purposes over 5 cc. from a child and 10 cc. from an adult. If we evacuate too much cerebrospinal fluid, the ventricles are emptied and compression of the cerebellum may arise. The flow should be spontaneous and suction ought not to be used. Sometimes nausea, vertigo, and severe headache follow the operation. and sudden deaths have been reported. For a number of hours after tapping the patient should remain recumbent.

Horsley's Operation for Chronic Spinal Meningitis.-Sir Victor Horsley ("Brit. Med. Jour.," Feb. 27, 1909) states that during the past ten years he has operated on a number of cases for what he calls chronic spinal meningitis. Such cases are commonly confused with tumor, are much more frequent than tumors, and are often cured or greatly improved by operation. The first published case of this sort was reported by Spiller, Musser, and Martin ("Univ. of Penn. Med. Bulletin," March, 1903). Martin performed laminectomy, found a "circumscribed meningitis," and cured the patient. In these cases a fluid accumulation is found and this fluid is stagnating and under pressure. The cord passes into a condition of sclerogliosis. The symptoms are pain, advancing loss of power in the legs, perhaps slight kyphosis, and eventually progressive and fatal paraplegia (compression paraplegia).

The pain in these cases involves an extensive area, not as in extramedullary tumor a small area supplied by one or two nerve-roots, and there may be hyperesthesia over an entire extremity, which does not occur in extramedullary tumor (Horsley, Ibid.). Horsley has never seen absolute abolition of tactile sense. The operation consists in laminectomy, opening the theca, washing it out with mercurial solution (1:500 followed by 1:2000), and closing

without drainage.

## XXV. SURGERY OF THE RESPIRATORY ORGANS.

DISEASES AND INJURIES OF THE NOSE AND ANTRUM.

Foreign bodies in the nose are usually introduced through the anterior nares, but in rare instances they enter by way of the posterior nares. Small particles are often expelled spontaneously; larger pieces collect mucus and epithelium and become fixed. Some materials swell after lodgment.

Treatment.—In many cases anesthesia is required. Illuminate the nostril, and, if the foreign body can be seen, insert a hook back of it and effect its removal by means of forceps. Some foreign bodies require to be pushed back into the nasopharynx. Occasionally expulsion may be effected by inserting a rubber tube into the unblocked nostril and telling the patient to blow forcibly through the tube. In serious cases a specialist should be summoned to remove a portion of the turbinated bone or to perform whatever operation he thinks best.

Inflammation and Abscess of the Antrum of Highmore (of the Maxillary Antrum).- The source of this disease may be inflammation of the nose or periostitis around the roots of the teeth. In some cases the natural opening into the meatus is patent; in other cases it is partly or completely blocked. Caries and necrosis may arise. The symptoms are pain, edematous swelling of the face, and thinning of the bone so that it may crepitate under pressure. When pus has formed, if the antral opening is patent, certain positions of the head will cause a purulent flow from the nose, and if a speculum is inserted pus may be seen as it flows into the nose. The opening of the maxillary antrum into the nasal channel is at the summit of the antrum; hence the antrum drains when the head is inverted. The ethmoidal cells and frontal sinus drain best when the patient is upright. Wipe the interior of the nose and place the patient with his head between his knees. If the nostril fills with pus, it comes from the antrum (Cobb). In severe cases the jaw expands, the eye protrudes, and great tenderness of the alveolus exists. Percussion exhibits a dull note. In making a diagnosis it is well to take the patient into a dark room, insert an electric light into the mouth and note the diminution of light-transmission on the diseased side as contrasted with the sound side. Transillumination may be easily practised by the use of a cautery electrode, protected by a small glass vial. Any cautery battery may be employed (plan suggested by Ohls). Exploratory puncture will settle a doubtful diagnosis. This may be by way of the lower meatus, the canine fossa, or the alveolar process.\*

Treatment.—Before pus forms order the use of hot fomentations and remove any diseased teeth. When pus has formed, evacuate it at once. Before performing a severe operation try the effect of opening into the antrum from the nose, by means of Krause's trocar, followed by insufflation of iodoform. If this procedure fails, other means may be employed. If the disease arises from a carious tooth, pull the tooth and push a trocar through its socket into the antrum. If the teeth are sound,

<sup>\*</sup> Cobb, in Boston Med. and Surg. Jour., May 7, 1896.

bore a hole with a large gimlet or with a bone-drill above the root of the second bicuspid tooth and one inch above the edge of the gum. A counter-opening should be made into the inferior nasal meatus. A drainage-tube is pulled from the first opening into the nose and is allowed to protrude from the nostril. Irrigate daily with normal salt solution. In three or four days discontinue through-and-through drainage, but prevent the first opening closing until the discharge ceases to be purulent. In severe cases make a

free incision through the canine fossa by means of a chisel.

Distention and Abscess of the Frontal Sinus.—The usual cause is an injury which may long antedate the symptoms. This injury causes or leads to blocking of the infundibulum; secretion accumulates and distends the sinus; and in some cases pus forms. In many cases the fluid slowly accumulates, and it requires years to produce marked symptoms. In other cases infection takes place, and the symptoms are positive and violent. If the outlet into the nose is not permanently blocked, the fluid may discharge itself from time to time. In the chronic cases there is rarely much pain. The chief sign is a swelling of the inner or upper part of the orbit, which swelling progressively increases and finally displaces the eye. If at any time acute symptoms supervene, there will be pulsatile pain, discoloration, and tenderness.

Treatment.—In some cases it is possible to pass a trocar upward from the nose into the sinus, and so drain and irrigate. In most cases an incision should be made through the soft parts, and the sinus opened by a trephine or chisel. After the sinus has been opened it must be curetted. The opening into the meatus should be restored and enlarged, and a drainage-tube must be passed from the forehead incision into the nostril. I usually prefer to open the

sinus by making an osteoplastic flap in the anterior wall.

## DISEASES AND INJURIES OF THE LARYNX AND TRACHEA.

Edema of the Larynx (Edema of the Glottis).—The causes of edema of the larynx are: acute laryngitis; chronic diseases, such as tuberculosis, malignant disease, or syphilis; inflammatory disorders, such as diphtheria and erysipelas; acute infectious diseases; Bright's disease; aneurysm; whooping-cough; pneumonia; quinsy; wounds of the larynx; wounds of the neck; scalds and burns of the larynx, and the inhalation of irritating vapors, such as those of ammonia and sulphur. The symptoms are sudden and rapidly increasing dyspnea, respiratory stridor, huskiness of the voice, and finally aphonia. The swollen epiglottis may be felt with the finger and may be seen with the help of a mirror.

Treatment.—In cases in which edema of the larynx is not excessively acute, introduce a gag between the teeth, hold the mouth open, take a knife wrapped to within one-quarter of an inch of its point, make multiple punctures into the epiglottis, and favor bleeding by the inhalation of steam. In severe cases perform intubation or tracheotomy.

Wounds and Injuries of the Larynx.—The larynx may be injured internally by foreign bodies, and externally by blows and cuts. A condition often met with is cut throat, the result usually of a suicidal attempt on the part of the patient or a homicidal effort on the part of an assailant. The cut of the suicide is usually in front; as a rule, it misses the great vessels, but divides the

cricothyroid or thyrohyoid membrane. The epiglottis may be incised, or even be cut off. If a large vessel is cut, death rapidly occurs. The immediate dangers of cut throat are hemorrhage, suffocation by blood in the windpipe and bronchi, or by displacement of parts, and entrance of air into veins. The secondary dangers are pneumonia, infection and sepsis, exhaustion, and secondary hemorrhage. The remote dangers are stricture and fistula (Keetley).

Treatment.—In wounds of the throat arrest hemorrhage, remove clots from the larynx and trachea, bring about reaction, asepticize the parts as well as possible, suture the deeper structures with silver wire, catgut, or kangarootendon, and the superficial parts with silkworm-gut, dress antiseptically, and place a bandage around the head and chest so as to pull the chin toward the sternum. If laryngeal breathing is much interfered with, perform tracheotomy. Feed the patient through a tube until union is well advanced. The old method of leaving the wound open is to be condemned. When sutures are used, primary union may be obtained. This fact was proved by Henry Morris.

Scalds of the Glottis.—(See section on Burns and Scalds.)

Foreign Bodies in the Air-passages.—The lodgment of foreign bodies in the air-passages is a frequent accident. Small solid bodies are usually expelled by coughing. Liquids and solids rarely pass beyond the larynx (except in laryngeal disease or palsy, wounds of the floor of the mouth, cut throat, and in people unconscious or very drunk). In vomiting during or after the administration of an anesthetic, or in the vomiting of drunkards, the vomited matter may find its way into the larynx or lungs. There is great danger of this accident in an operation upon a patient with intestinal obstruction who has stercoraceous vomiting. In most instances of foreign bodies lodged in the air-passages it will be found that the object was being held in the mouth when a sudden deep inspiration was taken (often during laughter). The symptoms are immediate, due to obstruction by the body and to spasm, and secondary, due to the situation of the body and the changes it undergoes or induces.

Lodgment in the pharynx causes violent dyspnea. The body can be seen or felt.

Lodgment in the Larynx.—In a severe case the patient fights madly for air; his face becomes livid and cyanotic; his veins stand out prominently; speech is impossible, though he may make noises and utter harsh cries; violent coughing begins, and then vomiting; he tries to force a finger down his throat and clutches at his neck; sweat pours from him; he feels a sense of impending dissolution, and he falls unconscious, with incontinence of feces and urine.\* In a less severe case violent dyspnea gradually departs and the patient lies exhausted; but dyspnea and cough are liable to recur suddenly at any time because of spasm, and they may be induced by a change of position. These attacks of fierce spasmodic cough are not at first linked with expectoration, but after inflammation begins there is a profuse and often bloody expectoration. Inflammation follows more rapidly the lodgment of a sharp or irregular body than it does that of a round or smooth body. Inflammation is apt to produce edema of the glottis, bronchopneumonia, or ulceration and necrosis of the larynx. Any sort of foreign body in the larynx may at any moment produce

<sup>\*</sup> See Moullin's graphic description in his "Treatise on Surgery."

spasmodic dyspnea, and is always very liable to cause edema of the glottis.

The body if bony or metallic can be detected by the x-rays.

Lodgment in the Trachea.—The immediate symptoms of a foreign body in the trachea depend on the shape and weight of the body, and whether it becomes fixed in the mucous membrane or moves to and fro with the air-current. A smooth, heavy body falls to the tracheal bifurcation, and, if it does not enter a bronchus, moves with every breath, and by its movement causes violent laryngeal spasm, cough, and whooping inspiration without aphonia. The patient is often conscious of the movements of the foreign body, and the surgeon may detect them with the stethoscope. The foreign body may be found with the Röntgen rays. A foreign body in the trachea is liable to cause death by dyspnea, or it may ascend so as to be caught in the larynx, or may even be expelled. Irregular or sharp bodies lodge in the mucous membrane, produce inflammation, frequent cough, and expectoration, and finally lead to ulceration. Bodies which swell from heat and moisture tend to lodge and to become fixed (seeds may sprout).

Lodgment in a Bronchus.—Foreign bodies in the bronchi seriously endanger life. They usually lodge in the right bronchus. When a small lungarea is obstructed the obstructed side shows diminished respiratory movement and murmur with occasional whistling sounds and large moist râles; the percussion-note is normal. When an entire lobe is obstructed all respiratory sounds are absent over it, and over the unobstructed lung respiration is exaggerated; the percussion-note over the obstructed area is at first resonant, but becomes dull. The x-rays will enable the surgeon to detect some foreign bodies in a bronchus. Lodgment in a bronchus may cause bronchopneumonia, abscess, hemorrhage, and even gangrene. In some cases the body has been expelled spontaneously. In rare instances people have lived for years with lodged foreign bodies. If death does not soon follow the lodgment of a

foreign body, an abscess is very apt to form.

Treatment.-If a foreign body lodges in the pharynx, try to pull it forward; if this fails, push it back into the esophagus. In lodgment in the larvnx or below, if the symptoms are very urgent, at once perform a quick larvngotomy. If the symptoms are not so urgent, get a complete history of the accident and find out the nature of the foreign body. Be sure a foreign body is retained in the respiratory tract, and determine what its situation may be. Often a larvngologist can remove a foreign body from the larvnx by means of forceps, a mirror and lamp being used for illumination. The fauces and upper portion of the larynx should have cocain applied to them to lessen pain and spasm. If the surgeon fails in extraction by forceps, and laryngotomy has been performed, continue the search through the opening in the cricothyroid membrane; if laryngotomy has not been performed, let the larynx be opened by thyrotomy (a vertical incision between the alæ of the thyroid cartilage, and the separation of these alæ to permit of exploration). After a thyrotomy suture the perichondrium with catgut. If the foreign body is in the trachea. perform ordinary tracheotomy; if it is in a bronchus, perform low tracheotomy. Tracheotomy prevents suffocation from laryngeal spasm or edema of the glottis. It may be possible to remove the body in the bronchus through the incision of a low tracheotomy, and this ought to be tried. By this method I succeeded in removing a pin, a bone, a bean, a tack, and a broken tracheotomy

tube from the right bronchus. The foreign body may be expelled through the tracheotomy wound; if it is not expelled, search the trachea and bronchi with Gross's forceps, with probes, with hooks, or with the finger. If the foreign body cannot be found, put the patient to bed and maintain a moist



Fig. 487.—Author's case of pin in bronchus removed by operation.

a tube. If the foreign body be extracted, do not insert a tube (unless edema the glottis exists or is likely to come on), do not suture the wound, but cover with moist gauze and let it heal by granulation. Morphin and sedative



Fig 488.—Gibbons' case of tack in the right bronchus removed by low tracheotomy, child six years old.

cough-mixtures are given. Gross says that even when a foreign body has long been retained an operation should be performed if the air-passages are not seriously diseased. What shall be done when a foreign body is lodged in a bronchus and we are unable to extract it through a tracheotomy wound or by tracheobronchoscopy? Truc said if "the patient is in danger of death" cut through the chest-wall and attempt to remove the body. He said this with a full knowledge of the difficulty of locating the body. This difficulty has been partly overcome by the x-rays, and it seems now more certainly our duty to operate than it was a short time ago. Nasiloff proposed to reach the obstruction by the posterior route after rib resection. Curtis attempted this, and though the patient died, his operation proves that the method is feasible. An operation by the posterior route should be performed at once if low trache-otomy fails. The danger of pulmonary collapse will be abolished by the use of a suitable apparatus to prevent it (page 901).

Tracheobronchoscopy.—Dr. Chevalier Jackson of Pittsburg has devised a tracheobronchoscope through which he has succeeded in removing foreign bodies from the trachea and from a bronchus. In 10 cases of foreign body in the bronchus he removed the offender in 7. In 7 cases of foreign body in the trachea he was successful in each case, but 2 of the cases required tracheotomy. Whenever there is dyspnea he always prepares to do tracheotomy ("Annals of Surgery," March, 1908). In Jackson's trained hands the instrument is most useful, but an untrained man with it would be like an untrained

man with a cystoscope.

## OPERATIONS ON THE LARYNX AND TRACHEA.

Tracheotomy.—The instruments required in this operation are scalpels, dissecting forceps, a dry dissector, hemostatic forceps, scissors, a tenaculum, aneurysm-needle, tubes, tapes, Paquelin cautery, needles, needle-holder, a



Fig. 489.—Blood-supply of the larynx and trachea (Esmarch and Kowalzig).

mouth-gag, tongue-forceps, foreign-body forceps, retractors, and, if membrane is present, feathers and a solution of bicarbonate of sodium. In a formal operation give chloroform, but in an emergency case this cannot be done. The patient may be placed supine with a sand-pillow under the neck and with the head thrown over the end of the table. If a child, Liston used to wrap it up to the neck in a sheet to prevent movements of the limbs, would seat himself on a chair, place the child upon the nurse's lap, and takes its head between his knees. The head must be exactly in the middle line, and extended (in an adult this gives two and three-quarters inches of trachea above the manubrium; in a child of ten, two and a quarter inches; in a child of six, about two inches). The operator stands to the right side when the patient is

supine. If bleeding is profuse when the surgeon is ready to open the trachea, place the patient in the Trendelenburg position with the neck extended. The trachea may be opened above or below the isthmus of the thyroid gland. The isthmus in an adult usually lies over the second and third rings (Fig. 490). The isthmus in a child usually lies over the first ring or even over the space between the cricoid cartilage and the first ring. The high operation is always

chosen except in cases where it is desired to search for a foreign body in a bronchus.

High Tracheotomy.—High tracheotomy is preferred because in this region the muscles are distinctly separated (Fig. 490), the main vessels of the neck and the inferior thyroid vessels are not encountered, the anterior jugular veins are small and have very few transverse branches, and the trachea is near the surface (Treves). The surgeon accurately locates the cricoid and thyroid cartilages. An incision is begun at the upper border of the cricoid cartilage, and is carried down precisely in the middle line for about one and a half inches. Treves advises the operator to steady the skin of the neck with the fingers of the left hand and to cut with the unsupported right hand (if the hand be supported, the respirations will interfere with the operation). The skin, the superficial fascia, and the anterior layer of the cervical fascia are incised, the sternohyoid and sternothyroid muscles are separated, and the fascia over the trachea is divided. This fascia is attached above to the cricoid cartilage, and it divides below into two layers to invest the thyroid body and its isthmus. If veins are in the line of the incision, they are pushed aside, but it is not necessary

to take the time to apply double ligatures. Even if bleeding is profuse, as soon as the trachea is opened and air enters freely into the lungs, venous congestion is relieved and bleeding is apt to cease. If hemorrhage be violent and the veins are not at once caught by forceps, it may be well to place the patient in the Trendelenburg position before incising the windpipe, in order to prevent entrance of blood into the lungs. Before opening the trachea the isthmus of the thyroid gland is pushed downward: if it cannot be pushed down sufficiently, a transverse incision is made through the fascia at the upper border of the cricoid cartilage, and the fascia, and the isthmus with it, is lifted off the trachea (Bose's method). A tenaculum is inserted into the cricoid cartilage in order to steady the tube. The back of the knife is turned toward the sternum, a finger being held upon the blade to prevent too deep a cut being made. The

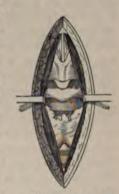


Fig. 490.—Parts exposed in tracheotomy (Esmarch and Kowalzig).

knife is plunged, as if it were a trocar, into the mid-line of the trachea above the isthmus, and two or three rings are divided from below upward. The hook is not removed until the operation is completed. If a foreign body is present, an attempt is made to remove it; if success attends the effort, no tube need be worn; but if the body is not found, a tube must be used. In croup or diphtheria remove membrane (by means of a feather and a solution composed of bicarbonate of sodium 3ii, glycerin 3i, water 3x-Parker) and insert a tube. edge of the cut is grasped with the dissecting forceps, the mucous membrane being included in the bite; the head is placed erect, the tube is introduced, and the tenaculum is removed. Secure the tube by tapes, and suture the wound below the tube. Remove the tube at the first moment consistent with safety. In croup or diphtheria put a screen around the bed; have the air kept moist by steam; remove the inner tube and clean it every two or three hours at first; clean the outer tube whenever required. Clean the larynx and trachea from time to time by means of a feather and Parker's solution. A steam spray atomizer may be used with advantage.

Quick laryngotomy must never be attempted upon a child under thirteen years of age, because of the small size of the cricothyroid space before this age (Treves). In view of the difficulty of introducing a tube and of wearing it so near the vocal cords, laryngotomy should not be performed for croup, diphtheria, or for any condition in which a tube must be long worn. The operation is performed as follows: Make an incision an inch and a quarter in length in the middle line, from above the lower edge of the thyroid to below the lower border of the cricoid cartilage. Divide the skin, superficial fascia, and deep fascia, separate the cricothyroid and sternothyroid muscles, divide the deep layer of fascia, and cut the cricothyroid membrane horizontally just above the cricoid cartilage. The tube must be shorter than the ordinary tracheotomy tube. An operation which opens vertically the cricothyroid membrane, the cricoid cartilage, and the upper rings of the trachea is called "laryngo-tracheotomy."

Intubation of the larynx (O'Dwyer's Operation).—Bouchot conceived the idea of intubation; O'Dwyer perfected it and made it a genuine scientific proceeding. The instruments required for the performance of this operation are a mouth-gag, an instrument to hold the tube and introduce it, and an instrument for extracting the tube. The collar of the tube has a perforation through which a piece of silk is fastened to draw out the tube. The child is wrapped in a sheet to secure the limbs, is seated in a nurse's lap, and its head is held by an assistant. The jaws are opened and held apart by the self-retaining mouth-gag. The surgeon sits in front of the patient, wraps a piece of rubber plaster about the index-finger of his left hand, and passes the finger into the child's mouth until its tip touches the epiglottis. He introduces the holder and tube (observing if the silk is free) along the surface of the tongue until the obturator touches the epiglottis; raises the epiglottis with the left index-finger, and passes the tube into the larynx; places the left index-finger against the tube, and withdraws the holder with the right hand. The silken thread is tied to the ear, and the nurse is directed to employ the thread to remove the obturator if it becomes obstructed or is coughed up. tube is removed in two or three days; if breathing is easy, it is not reintroduced; but if dyspnea recurs, it is replaced for two or three days more. If, in introducing the tube, a mass of false membrane is pushed before it into the trachea, breathing ceases, and, if the mass is not at once coughed up, tracheotomy must be performed. Feed these patients on semisolids rather than upon liquids (mush, soft eggs, and corn-starch); and if trouble occurs in swallowing these articles, feed by the rectum or by means of a nasal or an oral tube. In opiumpoisoning, in asphxyia, in acute traumatic pneumothorax, and in cerebral injuries, intubation may be associated with the use of Fell's apparatus (page 804).

DISEASES AND INJURIES OF THE CHEST, PLEURA, AND LUNGS.

Traumatic Asphyxia (Pressure Stasis; The Ecchymotic Mask).—This is a condition that occasionally arises when the trunk is subjected to sudden and violent compression. The compression may be upon the chest, the abdomen, or both; and in the majority of cases it has been very temporary. The ecchymotic condition arises immediately, and is manifested over the head and neck down to and sometimes below the clavicle. The hue is a

violet lividity. There are a great many spots in the skin in which the color is much deeper, which have been supposed to be hemorrhage, and similar spots exist on the aural, palatine, and pharyngeal mucous membranes. In some cases blood has been effused into the orbit. There has never been

a reported instance of intracerebral hemorrhage.

If death occurs, it results from associated injuries. The condition in the cases without severe associated injuries has soon disappeared, and entire recovery has followed. The view generally taught is that traumatic asphyxia is the result of compression of the abdominal veins, causing distention of the superior cava and its tributary veins, this region of the body showing the effect more than the limbs, because of the comparative feebleness of the valves (Villemin). One thing is sure, and that is that the condition is particularly apt to arise if the patient violently struggles to free himself from the compression; and many observers have held the opinion that actual vascular ruptures take place. There are certainly some cases, however, in which there is simply great venous and capillary distention in the skin without rupture, because pieces of skin have been excised and microscopic examination has indicated that there had been no blood effused. (See Winslow, "Medical News," Feb. 4, 1906; Birge, "Cleveland Medical Journal," Sept., 1905; Beach and Cobb in "Annals of Surgery," April, 1904; and Villemin, "Bull. et mém. de la Soc. Chir. de Paris," No. 9, 1906.)

Pleuritic effusion may arise from the lodgment of foreign bodies, from injury by fragments of a broken rib, from tumors, and from inflammation of the lung, but most usually is due to pleuritis. The commonest cause of primary pleuritis is tuberculosis. Inflammatory effusion is nearly always unilateral (except in tuberculous pleuritis, but even this form is often one-sided in

origin).

The signs of pleuritic effusion are: dulness on percussion over the area of effusion, this dulness, when the patient is erect, being at the lower part of the chest and ascending higher posteriorly than anteriorly (alteration of position alters the situation of the dulness); the intercostal spaces are widened, the intercostal depressions are obliterated, the intercostal muscles are rigid, and their rigidity lessens the mobility of the ribs (Przewalski). No breath-sounds can be detected in the area of percussion flatness when the collection of fluid is large, but in small effusions deeply situated the breath-sounds are often audible; the percussion-note above the liquid is hyperresonant or tympanitic, and is often associated, at the edge of the liquid, with a friction-sound; posteriorly, high up and near the spine, there are bronchial respiration and bronchophony. In cases of pleurisy with effusion pain almost or quite disappears with the advent of effusion, dyspnea comes on, and the patient lies upon the diseased side. Cough always exists if there is pleuritic effusion, and fever is usually present. In serous effusions the diagnosis may be confirmed by the aseptic introduction of a clean aspirating-needle.

The treatment in this stage is to discontinue arterial sedatives and to stimulate if the circulation calls for it. The exudation is removed by the administration of salines, compound jalap powder, or elaterium. If these means fail, if the effusion is excessive, or if it is producing dyspnea, at once aspirate. Aspiration should be performed for an effusion which fills the whole chest, which produces great dyspnea, or which has lasted for three weeks. In tuberculous pleuritis early aspiration is not advisable, but aspiration should be

performed if the fluid becomes purulent, if the effusion displaces the heart considerably, and if it adds notably to the dyspnea. If an effusion becomes purulent, the proper procedure is incision, resection of a portion of a rib,

and drainage.

Empyema is a collection of pus in the pleural cavity. It may begin suddenly, but rarely does so. Among the causes of empyema are those of serous effusion. Empyema is due to infection of the pleura, and in every case a bacteriological study should be made of the pus to discover the causative bacterium. The pneumococcus is the causative micro-organism in many of the cases which follow pneumonia. Pneumococci live but a short time, and in empyema due to pneumococci these micro-organisms may not be discoverable when the pus is evacuated. In most cases of empyema streptococci or staphylococci can be found in the pus. These micro-organisms may appear in an empyema induced originally by pneumococci (Stephen Paget). In empyema developing during or after typhoid fever typhoid bacilli may be discovered. In putrid empyema various bacteria are found. Bouchard thinks acute empyema has a special organism. Bacilli of tuberculosis are present for a time at least in tuberculous empyema, but may disappear, and are particularly apt to after mixed infection with pyogenic bacteria. Empyema may be due to a wound or contusion, an attack of pneumonia, tuberculous pleuritis, phthisis, influenza, pyogenic infection of a serous effusion, caries of a rib, specific fevers, especially typhoid, peritonitis, abscess of the liver, suppurating hydatid cyst of the liver, subphrenic abscess, malignant disease of the

pleura, gangrene of the lung, and pneumothorax.

Acute Empyema.-The signs are in reality those of pleuritis with effusion-viz., dulness on percussion, absent breath-sounds over the purulent matter, bulging of the intercostal spaces, and sometimes edema of the skin of the chest. The symptoms of acute empyema are dyspnea, pallor, cough, sweats, chills, and usually irregular fever, but fever may be absent. There is marked leukocytosis. The fingers may become clubbed. An empyema may pulsate, particularly an empyema of the left side. The cause of pulsating empyema has been much debated. The most probable explanation is that of W. J. Calvert ("Am. Jour. Med. Sciences," Nov., 1905). He says the requirements for such a condition are: "A firmly fixed, pulsating organ; distention of the pleural sac with fluid or air or solid material; and a collapsed condition of the lung." In all probability the thoracic aorta is the "fixed pulsating organ." The left parietal pleura is in close relation with the aorta, and most pulsating empyemas are left-sided. The right parietal pleural may be "pushed against the aorta." If a lung contains air, it is elastic and compressible to a degree that enables it to absorb the aortic impulse; if it is collapsed and solid it cannot, and aortic pulsations are transmitted to fluid in the pleural cavity and the thoracic wall pulsates. A neglected empyema may break into the lung, esophagus, or pericardium, through an intercostal space, or may point in the lumbar region. When an empyema is pointing externally, the condition is called empyema necessitatus. A total empyema is a condition involving the entire pleural sac. In a partial or localized empyema the purulent matter is encapsuled. After an empyema ruptures spontaneously it rarely heals without surgical interference, a pleural fistula, as a rule, persisting. A subphrenic abscess may

follow an empyema. When an empyema ruptures into a bronchus, pneu mothorax arises, as a rule. Empyema may cause death by compression o the heart and lung, pulmonary embolism, pericarditis, peritonitis, cerebra embolism, cerebral abscess, septicemia, exhaustion, or rupture into a bronchus.

A small empyema due to pneumococci occasionally, though very rarely,

undergoes spontaneous cure, the pus being absorbed (Stephen Paget).

A small empyema is occasionally cured by encapsulation with fibrous tissue.

Under exceptional circumstances even a large empyema may be cured by breaking externally or into a bronchus.

Empyema is so rarely cured spontaneously that it does not do to trust to nature, and practically almost every case will die without surgical treatment.

Double empyema is a rare and extremely fatal condition.

Chronic empyema may follow an acute empyema, or the condition may be chronic from the beginning. In chronic empyema the lung is compressed, shrunken, and strongly adherent, and the pleura is very thick. In some cases the pleura is over an inch thick. This thickening is brought about by the deposition of layer after layer of fibrin. In not a few cases a chronic empyema succeeds an acute one or is itself maintained because a drainage-tube has slipped into the pleural cavity and remains lodged.

A closed empyema is one in which no opening has been made by the sur-

Pus is rarely putrid; in an open empyema the pus is often putrid.

Treatment of Empyema.—The treatment is purely surgical, and the earlier it is applied the better. To delay allows the pleura to thicken and permits adhesions to form, conditions which prevent lung expansion and retard or even prevent cure. The results of operation are better in children than in adults; in small collections than in large; in recent than in advanced cases; in pneumococcus empyema than in empyema due to other organisms. The surgical methods comprise aspiration, incision, rib-resection, the operation of Schede, the operation of Estlander, and the operation of Fowler (see pages 903 to 908 inclusive).

In acute empyema general practitioners are very apt to aspirate, and yet aspiration is almost never curative. It may cure a pneumococcus empyema in a child and an encysted empyema, but even in these it will usually fail. Aspiration is not to be considered a method of curative treatment. It is to be regarded as the surgical treatment only in a tuberculous empyema in a young person with rapidly progressing phthisis, because in such a case incision will probably prove fatal (Lockwood). It is a very useful diagnostic expedient, and enables the surgeon to prove the existence of pus, and the pus which is obtained can be examined bacteriologically. In a very large effusion it is wise to aspirate and withdraw part of the effusion a day or two before operating. This enables the patient to take an anesthetic with greater safety and obviates the danger attending the rapid evacuation of a large amount of pus.

In a recent empyema incision and drainage or rib resection and drainage will often cure the case, and yet many of the results are unsatisfactory. In some cases the discharge ceases and yet pulmonary function is not completely restored. In other cases a pleural fistula persists. If a profuse discharge is maintained, amyloid disease may arise. An acute empyema is to be drained y intercostal incision or by resection of a rib (page 904). A chronic closed

empyema is drained in the same manner, and if the lung will not fully expand and remains stationary for one year, Schede's or Estlander's operation is required. An open chronic empyema, in which the lung will not expand, requires the operation of Schede, Estlander, or Fowler (pages 906 and 907). Extensive decortication is sometimes impossible, and then Ransohoff's operation may be done. He calls it discission of the pulmonary pleura (page 908). When there is an external opening which persists and which joins a long, narrow cavity, the condition is spoken of as pleural fistula, and pleural fistula is often produced by the prolonged use of a drainage-tube and sometimes by caries of a rib. Even if there is no opening on the cutaneous surface, there may be one into a bronchus. A pleural fistula may sometimes be cured by dilatation of the sinus. If this fails, and it usually does, it is the custom to resect one or more ribs.

Before resorting to operative treatment try the injection of bismuth paste. We owe this method to Dr. Emil Beck. This plan will often succeed. Ochsner has strongly commended it ("Annals of Surgery," July, 1909). The injection is made with a glass syringe and the material should fill but not stretch the cavity. After injecting the paste the external opening of the fistula is plugged with gauze. The treatment is begun with solution No. 1 (1 part of subnitrate of bismuth devoid of arsenic and 2 parts of yellow vaselin).

This is used every second day until pus has practically disappeared. Then solution No. 2 is substituted for it (30 parts of bismuth, 60 parts of yellow vaselin, and 10 parts of paraffin). The injections are made often enough to keep the sinus and pocket full. They are made at first every day, then every other day, and so on until, finally, every eighth or tenth day is often enough. If poisoning should arise from these injections Beck advises the injection of olive oil at a temperature of 110° F. to dissolve the paste and favor its evacuation.

Non-traumatic Pneumothorax.—By the term pneumothorax is meant the presence of air in the pleural cavity. As a rule, besides air there is serous fluid or pus. It may be due to the rupture of an empyema into a bronchus; to the rupture into the pleural sac of a tuberculous area, an area of gangrene, an abscess of the lung, an air-cell in a state of emphysema, or of pulmonary tissue softened because of hemorrhagic infarction. The immediate effect of the entrance of air into the pleural sac is to compress the lung, the degree of compression being in proportion to the amount of air present. In severe cases the lung is squeezed against the vertebral column, and the heart, the diaphragm, and even the liver are displaced. In some cases, where the admission of air does not continue, the amount set free in the pleural sac is absorbed. In most cases pyopneumothorax (empyema) follows.

Symptoms.—The symptoms usually arise suddenly, and consist of distressing dyspnea, pain in the chest, lividity, and rapidity and weakness of the pulse. In some cases of phthisis the symptoms are not very severe. It has been pointed out that occasionally in phthisis pneumothorax seems actually to benefit the tuberculous area in the lung. The physical signs of pneumothorax are as follows: The affected side of the chest is bulged and immobile, and the heart is displaced, especially if the condition affects the left side. Palpation discovers that vocal fremitus is lessened or absent. On auscultation it is found that the breath-sounds are very feeble or absent. The voice is transmitted as a metallic sound, the râles sound metallic, and on coughing there

may be metallic tinkling. The percussion-note is tympanitic. In some rare cases the percussion-note is dull. When fluid gathers, there is a positively dull note on percussion over the fluid.

Treatment.—Osler says the treatment should be the same as that of pleurisy with effusion. In many cases it is wise to perform paracentesis without suction to remove air and serous effusion. If pus forms, a rib should be resected and a tube inserted (see Empyema). In pneumothorax occurring during chronic phthisis operation is of great service. In cases with rapidly progressive phthisis it is practically useless.

If the opening into a bronchus or air-cell remains patent, aspiration will not get rid of air; the air will enter into the pleura as rapidly as the aspirator removes it. Incision has dangers of its own: the diaphragm is flapping during respiration and may be injured (Fowler), and when the pleura is opened, there is a great alteration produced in the air-pressure in the chest, and the patient may "drown in his own secretions." After incision irrigation is not justifiable, because the fluid may enter a bronchus and produce suffocation (Fowler).

West's rules are those I follow\*—West says early incision is dangerous. In an early stage use paracentesis without suction. This will often relieve the patient. If paracentesis does relieve him, wait a while and perhaps repeat the operation if the symptoms again become severe. If paracentesis does not relieve, incise, resect a portion of a rib, and drain. If pus forms, an incision must be made and a portion of a rib resected, to afford exit to the fluid.

Fowler points out that if the lung is bound down by adhesions, incision is dangerous but justifiable. Operation at the proper time often prevents the lung being bound down by adhesions.

Acute Traumatic Pneumothorax.—This is produced by the sudden admission of a quantity of air into the pleural cavity as a result of a wound of the chest-wall. A small quantity of air, or the gradual introduction of considerable air, does not, as a rule, produce very serious symptoms. The sudden admission of a quantity of air causes very dangerous symptoms, and even death. A quantity of air may be admitted rather suddenly as a result of an accident or during the performance of a surgical operation which opens the pleura. It sometimes arises during the removal of tumors from the chest-wall, during operations upon the lung, and during empyema operations. As a rule, when pulmonary adhesions exist, dangerous symptoms do not arise, even when the pleura is widely opened, and adhesions exist in 25 per cent. of empyema cases seen by the surgeon.†

It was formerly taught whenever the pleura is opened there is a strong tendency to the development of pneumothorax, but West has shown that the surfaces of the pleura often cohere with a force superior to pulmonary elasticity, and in such cases pneumothorax does not arise.

In surgical operations in which it is necessary to open the pleura widely (as in operation for sarcoma of the chest-wall) the surgeon endeavors to prevent acute pneumothorax which may prove fatal. This may be done by operating in the Sauerbruch negative pressure chamber (page 901), or by applying positive pressure (page 902).

Symptoms.-When the pleura is opened during an operation or by an

<sup>\*</sup> British Medical Journal, Nov. 27, 1807. † Rudolph Matas, Annals of Surgery, April, 1809.

injury, the symptoms may be trivial and transitory, may be tolerably severe, may be extremely grave, and the patient may quickly die (Quénu and Longuet). Rudolph Matas sets forth the symptoms as presented by the French observers:\*

The mild symptoms are a weak, slow pulse and irregular, noisy respiration.

The severe symptoms are slow pulse, slow and irregular respiration, and

dyspnea, continuing after the anesthetic has been withdrawn.

The grave symptoms are cyanosis; collapse; small, weak pulse; shallow and noisy respiration; and spells of syncope. Death may occur suddenly from inhibition, or later from mechanical asphyxia (Matas).

Treatment.-Various plans have been adopted: suturing the opening in the pleura; plugging the opening; pulling the diaphragm into the wound in the

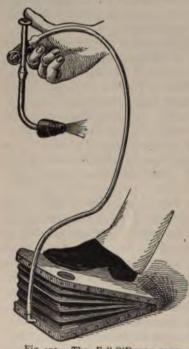


Fig. 491.-The Fell-O'Dwyer appag ratus. This illustration shows an early model; since then the bellows has been improved by the addition of a strong wooden frame, which holds it steadily, and is provided with a long arm that acts as a powerful foot-piece for compressing the machine with the least amount of muscular effort.

chest-wall and suturing it; and grasping the lung and suturing it to the wound. Whenever the pleura is to be widely opened, use a positive pressure apparatus, and when the operation is complete, suture the lung to the margin of the opening in the pleura with a continuous catgut suture. Parham, Keen, and the author have followed this plan, using the Fell-O'Dwyer apparatus, and the lung was kept from collapsing. †

The Fell-O'Dwyer apparatus is shown

in Fig. 401.

O'Dwyer's tube is introduced into the glottis as is the tube in intubation, and is attached to a bellows, the lung is inflated, respiration is maintained by the use of the bellows, and collapse, with all its dangers, is avoided. The modern positive pressure apparatus is better (page 902).

Contusions and Wounds of the Chest.-Contusions.-A contusion may be trivial and limited to the superficial parts of the chest-wall; it may involve the muscles; it may be associated with fracture of the ribs or sternum or with visceral injury.

Symptoms.-In an ordinary contusion without visceral injury there are considerable pain, discoloration, and often

much swelling. The patient prefers to lie upon the back and the respiration is abdominal. After a severe blow upon the chest there is great shock and may even be instant death. The condition of shock so produced is called concussion of the chest. After a severe blow upon the chest a limited area of

\*Annals of Surgery, April, 1899. †F. W. Parham's paper on "Thoracic Resection for Tumors Growing from the Bony Walls of the Chest." Read before the Southern Surgical and Gynecological Association, November, 1898.

inflammation may arise in the pleura (traumatic pleuritis). Severe visceral injury is announced by positive symptoms. A contusion of the lung causes pain, cough, expectoration of bloody mucus, dyspnea, and possibly distinct hemoptysis. Over the contused region the percussion-note is dull and on auscultation crepitus is audible. A traumatic pneumonia always follows. This involves a limited area of lung tissue, but genuine croupous pneumonia may arise.

In rupture of the lung the physical signs are dependent on the extent and situation of damage. A minute rupture would not produce definite physical signs. If the lung is ruptured and the pleura is not, there will not be pneumothorax, but there may be cellular emphysema first becoming evident at the root of the neck. If the pleura is torn as well as the lung, there will be pneumothorax and hemothorax, the amount of hemorrhage depending upon

the situation and extent of the injury.

Le Conte ("Annals of Surgery," March, 1908) points out five ways in which rupture may be caused: (1) Bruising (simply causes subpleural echymosis); (2) bursting (violent force, and a lung unable to empty itself of air broken as an inflated paper bag is broken by a sharp blow). The question to whether the glottis must be closed for such an injury to occur is not settled; (3) penetration by a green-stick fracture of a rib; (4) compression of the gagainst some resistant structure; (5) tearing, when the lung has previously adherent to the wall of the chest.

These five causes might be sententiously designated as bruising, bursting,

Puncturing, squeezing, and tearing.

The symptoms are shock, dyspnea, cough with or without bloody expectoration, rapid and irregular pulse, cyanosis, emphysema (appearing first over the region of injury if a broken rib penetrated the lung, and first at the root of the lung is ruptured, but the pleura is not), and in some cases pneumo-

thorax and hemothorax (see Robt. G. Le Conte, Ibid.).

Rupture of the diaphragm causes pain, dyspnea, and often vomiting. The stomach or intestine may pass into the pleural sac. If this happens, there will be a tympanitic percussion-note over the displaced viscus and symptoms will vary with the viscus involved. Such a diaphragmatic hernia may become strangulated. (See page 1146.) In a case in the Jefferson Medical College Hospital, in which the stomach passed into the left pleural sac, there were persistent vomiting, violent pain in the chest and upper abdomen, great thirst, and displacement of the apex-beat. The condition may be confused with pulmonary rupture causing pneumothorax, but in rupture of the diaphragm nausea and vomiting are prominent features, whereas, in pulmonary rupture, if they exist at all, they are early and temporary; further, in rupture of the diaphragm the tympanitic percussion note is not found over the pleural apex, but in pulmonary rupture with pneumothorax a tympanitic note is found all over the entire pleural cavity (Le Conte, Ibid.).

Treatment of Contusions of the Chest.—A contusion of the chest-wall is treated as directed in the section on Contusions (page 259), and the chest is strapped with adhesive plaster, as in the treatment of fractured ribs. In concussion of the chest the treatment for shock is applied. It may be necessary to employ artificial respiration for a time. If a diaphragmatic hernia is diagnosticated, the abdomen should be opened, the displaced viscera restored to

their proper abode, and the diaphragm sutured. The diaphragm may also be reached by resecting several ribs and opening the pleural sac. In contusion of the lung cold is applied to the chest, and any inflammation which arises is treated according to general rules. In rupture of the lung the case may be treated expectantly, but dangerous and continued bleeding or pneumothorax may render surgical interference necessary. For pneumothorax paracentesis without suction is employed. If this fails, it may be repeated. If it fails again, resect a portion of a rib and put in a tube. If bleeding is dangerously profuse resect a portion of a rib and insert a drainage-tube into the pleural cavity.

Wounds of the Chest .- Non-penetrating wounds are not particularly grave, and are treated according to general principles, the chest being immobilized. Penetrating wounds are extremely grave, as viscera are apt to be injured. In such a wound an intercostal artery may be severed or the internal mammary artery may be divided. An intercostal artery is rarely divided unless a rib is broken. The surgeon should always examine carefully in order to determine whether an intercostal artery or the internal mammary artery has been divided, and, in doing so, should bear in mind the admonition of Matasthat is, the bleeding from these vessels may be internal, the blood collecting in the pleural sac. The pericardium or heart may be injured (page 401). A wound of the pleura is usually, but not always, associated with a wound of the lung. If the lung is injured, there are usually great shock, pain in the chest, dyspnea, and cough. In a large wound, damage to the lung will be indicated if air is sucked into the wound during inspiration and expelled during expiration, and blood is forced out of the wound by coughing. The lung may be visible or may protrude (protrusion of the lung). In a small wound it is often difficult and sometimes impossible to determine whether the lung has been injured. Pneumothorax with pulmonary collapse proves it has. Severe hemothorax strongly suggests it. Spitting blood does not prove it. In some severe cases there is no hemoptysis; in some slight bruises the amount of blood coughed up is large. Emphysema about the wound does not prove lung injury. An incised wound of the lung is apt to produce rapid death from hemorrhage, especially if the wound is at the root of the lung. A pistol-bullet or a sporting-rifle bullet is not usually productive of great primary hemorrhage; but infection probably follows, and secondary hemorrhage is apt to occur. The modern military-rifle ball passes through, rarely lodges, is aseptic, and often produces astonishingly little trouble. A pistol-bullet and an old-time rifle bullet may lodge or may perforate.

Treatment.—Bring about reaction as previously directed (page 264).

An incised wound of the chest, if large, should be carefully inspected. If the wound is small, cut down layer by layer until the depths of the wound are reached. Disinfect the wound and arrest hemorrhage. If the pleura is not open, proceed according to general rules. If the pleura is found to have been opened, suture it with catgut, close the superficial wound, dress with gauze, and immobilize the chest-wall.

The above proceeding should be carried out whether it is or is not believed that the lung has been damaged, provided there is no pneumothorax and no violent hemorrhage. What course shall be pursued if the lung has been injured by a stab? If hemorrhage does not threaten life and there is no pneumothorax, the patient is kept at rest and observed. If pneumothorax occurs,

the pleural sac must be drained by means of a tube, because clots must be evacuated and infection should be anticipated. If hemorrhage into the pleural sac persists, active measures become necessary. The use of ice-bags and drugs is but waste of time. Some surgeons believe that the mere closure of the external wound leads to arrest of hemorrhage, blood accumulating and making pressure. It is true that hemorrhage often ceases after suturing or plugging a wound and strapping the chest, but it is not probable that it ceases because of these measures. Blood in the pleura usually remains unclotted for several or many days. Further, as Le Conte shows, as the blood is forced against the root of the lung, the right heart is engorged, the blood-pressure is raised, and the bleeding continues.\*

Bleeding from the lung can often be arrested by inserting the end of a drainage-tube into the pleural sac. In cases where a drainage-tube is inserted into the pleural cavity and free drainage established, the pleura is immediately filled with air, and the muscles of respiration are kept from acting on the lung. The lung contracts by its own elastic tissue, as well as by the pressure exerted by the pneumothorax, and at the same time the presence of the air favors clotting in the severed vessels.† If the insertion of a tube fails, or if the bleeding is rapid and obviously seriously threatens life, several ribs must be rapidly resected and the bleeding part explored. In some cases the bleeding may be arrested by ligation, in some cases by packing a small wound with gauze, in some cases by the suture ligature. In a violent secondary hemorrhage following a gunshot-wound of the lung the author packed the entire pleural cavity with sterile gauze to obtain a base of support, and arrested the bleeding by carrying iodoform gauze directly against the oozing surface.‡ I did the same thing recently on a Chinaman suffering from a gunshot wound of the lung. The hemorrhage was arrested and he lived three weeks, dying finally from pericarditis. After directly arresting hemorrhage from the lung, turn clots out of the pleural sac and insert a drainage-tube. In a perforating wound inflicted by a bullet, reaction must be brought about, the wound dressed antiseptically, the chest strapped, and the patient kept quiet. If pneumothorax occurs, the pleura should be drained with a tube. If hemorrhage occurs, it should be met as directed above. In a wound in which the bullet has lodged, an examination should be made to see if the bullet is under the skin, and if it is, it is removed after the patient has reacted. It should always be borne in mind that a pistol-bullet may be deflected by a rib or may pass from the front to the back part of the chest by making a burrow under the skin (a contour wound). If a bullet is lodged, no attempt should be made to remove it unless an operation must be done for bleeding, unless the bullet causes trouble, or unless it is felt under the skin. Under no circumstances conduct a long search for a bullet. If emphysema of the chest-walls is moderate, strapping or a bandage will control it; if it is great, make multiple punctures and then apply pressure. In protrusion of a portion of the lung try to restore the protrusion; but if restoration is impossible or if gangrene seems likely to occur, ligate the base of the protrusion with silk and cut away the mass.

Occluding Pulmonary Embolism.—By this term we mean an embolism which completely blocks the pulmonary artery or some of its chief branches.

<sup>\*</sup> Annals of Surgery, April, 1800.

<sup>†</sup> Le Conte, in Annals of Surgery, April, 1899. ‡ Annals of Surgery, Jan., 1898.

Such cases occasionally follow a surgical operation. The clot is derived from a vein. The calamity is most apt to occur between the second and fourth weeks after an operation (Bartlett and Thompson, in "Annals of Surgery," May, 1908). If the pulmonary artery is completely blocked death occurs at once. If one branch only is blocked the patient may recover if the heart is sound and strong. If the artery proper is partly blocked, the patient has a period of suffering and dyspnea before death, but death is sure to occur from subsequent complete blocking.

Bartlett and Thompson (Ibid.) report 22 cases of occlusive pulmonary embolism, 20 of which were fatal. The greatest cause in a surgical operation seems to be varicose veins, especially about an abdominal or pelvic tumor.

The symptoms are sudden collapse, cyanosis or pallor with livid lips, the pulse at the wrist is absent or very rapid, and irregular. There are pain in the chest, intense dyspnea, dilated pupils, and early unconsciousness. The surgeon must bear in mind the danger of embolism and endeavor to prevent it in operations by handling and exposing viscera as little as possible, by applying ligatures above all clots in veins and all varicosities, and removing the affected structures.

Treatment.—There is nothing to do medically.

Trendelenburg of Leipzig suggests surgical treatment ("German Congress of Surgery," 1908). He points out that death is not always sudden (in 7 cases out of 9 the victim lived from ten minutes to one hour), and advises opening of the pulmonary artery and removal of the embolus. It was tried three times. One died on the table; one died in fifteen hours from cardiac failure; one lived for thirty-seven hours and died of reactionary bleeding from the internal mammary artery.

Abscess of the lung may follow ordinary pneumonia. It is apt to follow aspiration-pneumonia. It is usually caused by streptococci or staphylococci, but it may result from pneumococci or colon bacilli. These germs may reach the pulmonary tissue by direct entrance from adjacent organs, by way of the blood or by way of the bronchi and alveoli. Osler tells us that pulmonary abscess may result from the aspiration of septic particles after "wounds of the neck, operations upon the throat," and suppurative lesions of the nose, larynx, or ear.\* Aspiration-pneumonia may develop when there is difficulty in swallowing from any cause, when there is profound exhaustion, and when there is palsy or incoordination of any of the muscles of deglutition. Cancer of the esophagus may be a cause; so may perforation of the lung by an abscess, wound of the lung, impaction of a foreign body in the lung, suppuration about a focus of tubercle or a metastatic abscess. A pulmonary abscess may be of trivial size or it may be very large, involving an entire lobe. There may be one abscess, several, or many. When suppuration results from aspiration-pneumonia or blood-infection, there are usually multiple abscesses.

Symptoms.—The expectoration is not frequent, but is profuse, and during a paroxysm mouthfuls are coughed up in rapid succession. The expectorated matter is sour or very offensive in odor and contains fragments or shreds of pulmonary tissue, which can be identified as such by the microscope. The patient lies upon the diseased side in order to keep the pus

<sup>\*</sup>See Osler's "Practice of Medicine."

from running into the bronchi and causing cough. When the cavity fills and pus reaches the bronchi, violent cough and expectoration begin, continue until the cavity is partly or entirely emptied, and then subside, perhaps for several hours. If the abscess-cavity is large and full of pus, an area of dulness on percussion can be mapped out. When the pus is coughed out and the air enters, physical signs of a cavity are clear. The x-rays often show the situation of such a cavity.

The course of abscess of the lung is usually acute. There are fever of the hectic type, rapid loss of weight, weakness and rapidity of circulation, dyspnea, pallor, sleeplessness, and great weakness. Gangrene may arise; empyema or pyopneumothorax may develop; very rarely the abscess breaks through the chest-wall; recovery may follow spontaneous evacuation or drainage by coughing up pus; death may result from exhaustion or secondary septic lesions. If operation is performed, from 50 to 60 per cent. of the patients will recover.

The treatment is purely surgical (pneumotomy). Make an incision over the cavity. Resect a portion of one or more ribs. Expose the pleura. If the two layers of the pleura are not adherent, suture them together and wait two days. If they are adherent, proceed at once. Search for the abscess with an aspirating needle. When the cavity is found, open into it with the cautery and insert a drainage-tube (page 908).

Gangrene of the Lung.—This term means the putrefaction of a devitalized portion of pulmonary tissue. The tissue is devitalized by the action of pyogenic micro-organisms. Gangrene may follow abscess, bronchitis, or pneumonia, or may be due to diabetes, to embolism of the pulmonary artery, bronchiectasis, tuberculosis, malignant disease, wounds, or the lodgment of foreign bodies. Gangrene may be circumscribed or diffused. There may be one cavity, small or large, or multiple cavities may form. The gangrenous area putrefies, softens, and the softened matter may be expectorated, a gangrenous cavity being formed. In the rare cases which undergo spontaneous cure the cavity is, after a time, surrounded by fibrous tissue and obliterated by granulations.

Symptoms.—Expectoration occurs only now and then, but at each seizure a great quantity of matter is brought up and this matter is extremely offensive. Occasionally there is no expectoration. The patient, as in lung abscess, lies upon the diseased side. The expectorated matter is mucopurulent, contains particles or shreds of pulmonary tissue, bacteria, and altered blood. The fetor of the pus is much greater than is the fetor of the pus of an abscess. The breath is very foul. Physical signs may indicate either consolidation or a cavity. There are hectic fever, great exhaustion, deathly pallor, and diarrhea. Pulmonary hemorrhage is not unusual, and complications spoken of in the article upon Abscess may occur (page 898). Recovery sometimes ensues, the cavity closing by granulation. Death may take place in a few days. Often the patient lives for weeks, being sometimes better and sometimes worse, dying fmally from exhaustion or from the effects of a complication.

The treatment is to operate as for pulmonary abscess.

Treatment of Pulmonary Tuberculosis.—Surgical Treatment.— For the past decade surgical thought has been actively directed toward placing on a scientific footing operations for pulmonary phthisis. The

matter is still in a transition stage, and operations at present have a v limited field of application, although Sonnenberg and others have repor cures. Baglivi, in 1643, endeavored to tap and inject tuberculous ca ties. Hastings and Stucke did the same thing in the eighteenth centr Mosler, a number of years ago, attempted to treat cavities by introducin trocar into the cavity and injecting permanganate of potassium solut through the cannula. Patients were not benefited by this procedure. plan was revived by Pepper in 1874. The results are bad and the operat is dangerous. Hillier tried injection of corrosive sublimate into the lu parenchyma, but the effect of the injections was disastrous. Vidal vocates counter-irritation by the actual cautery and maintains that congest improves nutrition. When the strength of the patient is well preser and the pulmonary lesion is circumscribed and slowly progressive, it n be justifiable to perform an operation, open the cavity, and treat it dire (pneumotomy). That pneumotomy might be performed successfully was s gested to surgeons by observing that some patients recovered after swo thrusts into the lung. Fowler says it is not justifiable to operate if the ease has come "to a standstill." The same surgeon states that the only acc sible region is bounded above by the clavicle, to the inner side by the mabrium, to the outer side by the lesser pectoral muscle, and below by second rib.\* This operation does not cure any one, but it may cause d tinct improvement when there is hectic from an ill-drained cavity conta ing the products of a mixed infection. In an advanced case there is usua more than one cavity, and then the operation is contraindicated. Before attempting it, be sure the case is advanced and not incipient and that the cay is single. Locate the cavity by auscultation, percussion, and the x-rays. (§ Willard, "Jour. Amer. Med. Assoc.," Sept. 20, 1902.)

Mauclaise says that pneumotomy is justifiable only in circumscrib tuberculous cavities without peripheral infiltration and in pulmonary a scesses.† Bronchiectatic cavities are usually multiple; they are exceeding difficult to locate, and treatment by pneumotomy should not be attempted in the treatment of pulmonary tuberculosis resection of the diseased are has been proposed (pneumectomy). Tuffier successfully performed to operation. Surgeons, as a rule, do not believe in pneumectomy. Reclavoices the general opinion when he says the operation is not required if the area of disease is very limited, as such a condition is frequently curable medicinal means, and it does no good if the area of disease is extensive.

It has long been known that pneumothorax might benefit a tubercule lung. Attempts have been made by Farlanini and Murphy to cure phthi by the deliberate production of artificial pneumothorax. Murphy injenitrogen gas into the pleural sac, and believes that the method is of great valuation is maintained that Murphy's operation occludes the lymph-channels, powents bleeding, compresses the lung, favors the development of fibrous tiss and leads to healing of cavities. Every third or fourth week 120 c.c. of nitrog gas are injected into the pleural sac. (See Willard in "Jour. Amer. Mac Assoc.," Sept. 20, 1902; Murphy's paper before Amer. Med. Assoc. in 186

<sup>\*</sup>See the very full and thoughtful article by George Ryerson Fowler on "The Surg of Intrathoracic Tuberculosis," Annals of Surgery, Nov., 1896.
† La Tribune médicale. Sept. 21, 1893.

‡ Revue de Chirurgie, Nov. 11, 1895.

Lernke, in "Jour. Amer. Med. Assoc.," Oct. 14, 21, 28, 1899.) The operation is not dangerous, but its value is greatly diminished if there are adhesions. The more numerous the adhesions the less the usefulness of the method. Adhesions prevent pulmonary collapse. The method is valuable in hemoptysis.

Allis suggested that in extensive unilateral tuberculosis of the lung resection of a number of ribs will favor cure by permitting retraction of the chest-wall.\*

This operation is founded on the belief that the chief element in effecting a cure is the formation and contraction of fibrous tissue. Pulmonary collapse and abolition of movements favor the formation of fibrous tissue. In this operation the pleura is not opened. Quincke, Landerer, and others remove portions of ribs with periosteum along the axillary line. Some surgeons remove portions of ribs and periosteum from directly over the lesion. Freeman removes portions of ribs without periosteum and applies a truss to push in the chest wall ("Annals of Surgery," July, 1909). Friedrich, of Marburg, removes all the ribs from the second to the tenth inclusive and mobilizes the first rib (thoracicoplastic pleuropneumolysis with subcostal apicolysis). The pleura is not opened. He used to remove the periosteum, but does so no longer. He now leaves the periosteum so that after a time enough bone will reform to prevent lung bulging on coughing.

## OPERATIONS ON PLEURA AND LUNGS.

Intrathoracic Operations Under Positive or Negative Air-pres-Sure.-When under ordinary conditions the chest wall is widely opened the lung often rapidly collapses and the patient is placed in deadly peril (see Acute Traumatic Pneumothorax on page 893). The reality of the danger has a great extent retarded progress in the surgery of the heart, lungs, and lower Portion of the esophagus. Of late, however, methods have been devised for maintaining normal respiratory movements and preventing pulmonary colapse during operations which open the pleura. There are two forms of pres-Sure apparatus and each form finds warm advocates. Negative pressure is the form that is advocated by Sauerbruch. In Sauerbruch's negative pressure Chamber the lung is kept from collapse by suction exerted upon its exposed Surface. Positive pressure is advocated by Brauer. Positive pressure keeps the lung from collapsing by distending it from within. The two methods act similarly in many respects. Clinical observations and numerous experiments Seem to prove that "emphysema, persistent pneumothorax, difficulty of narcosis, and infection of the pleura are not dangers associated with the use of positive Pressure as such" (Samuel Robinson and George Adams Leland, in "Surg., Gynecol., and Obstet.," March, 1909).

The Sauerbruch Chamber.—This is an air-tight cabinet. The sides are of boards covered with tin, the corners being soldered. The roof is of glass. The sides contain air-tight windows. There is one air-tight door.

The room is lighted by electricity and contains a telephone. The larger chambers have a communicating room. Instruments which are wanted

<sup>\*</sup> Allis, to State Med. Soc. of Penna. in 1891.

## Surgery of the Respiratory Organs

ced in this room so that the surgeon may get them. The ects outside of the cabinet and a tightly fitting rubber collar he neck. The body and legs are surrounded by a canvas-cow he interior of which is in communication with the external a chamber is sufficiently large to hold the patient, the surgeon t. By means of an electric suction air pump, the valve of which egative pressure is obtained and is continuously maintained. The patient's thorax is exposed to the suction of negative the bronchioles are subjected to ordinary atmospheric pressure.

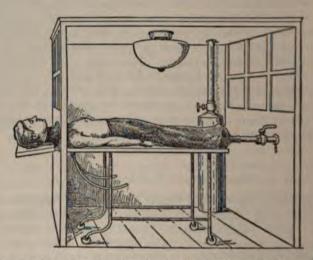


Fig. 492.—Sauerbruch's cabinet: Position of patient in chamber ready for openegative pressure.

even when a wide opening is made in the chest-wall, the lung does. The operator does not suffer from the negative pressure.

The Positive Pressure Apparatus.—Numerous apparatus devised.

This used to be done by the Fell O'Dwyer apparatus (Fi larynx was intubated and bellows were used. It can be done w is uncertain and difficult to use.

Brauer advocated the following plan: When the patient thetized and the surgeon is ready to open the pleura, a glass ca the patient's face and the air in the case is condensed by means

Bauer subsequently modified the head chamber so that wrists of the anesthetist are admitted within it. Some sur compressed air by the nose, the mouth being sealed. Some tion from the mouth. The trouble with this method in many pletely satisfactory tube has yet been made. As a general to give it is by a well-fitting face mask. A small motor mair pump and thus we dispense with the trouble and un

reservoirs Robinson and Leland\* state that any positive pressure apparatus consists of four elements: (1) A supply of compressed air; (2) an anesthetizing segment; (3) a device for introducing air and ether into the respiratory tract; (4) a means of varying the resistance of exhaled air (Fig. 493).

Exploratory Puncture of the Pleural Sac.—Puncture often gives valuable information as to the existence of fluid in the pleural sac and as

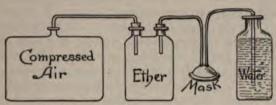


Fig. 493.—Scheme of apparatus for the maintenance of distention of the lung by positive pressure (Robinson and Leland).

to the nature of the fluid. The operation must be performed with aseptic care, otherwise a serous effusion might be converted into a purulent effusion, and either a serous or a purulent effusion might be rendered putrid. A large hypodermatic syringe with a long and strong needle is used for exploratory puncture. A slender needle breaks easily and is unsafe. In order prevent breaking of the needle impress upon the patient the absolute necessity of keeping quiet and avoiding any violent respiratory or general rement during the operation. It is not desirable to stick the lung, although harm rarely results from such an accident. If no fluid is found in the pleura one trial, several other punctures should be made. What is known as a dry tap may be due to the entire absence of fluid, to encapsulation of fluid in a region not invaded by the needle, to the lodgment of the point of the needle in thickened pleura or in an adhesion, or to blocking of the lumen of the needle with coagula. Fowler points out that if a person has been recumbent for a long time, the upper layer of fluid may be clear while the lower layer is purulent. † The fluid should be collected in a sterile glass tube and subjected to a careful bacteriological study.

Paracentesis Thoracis.—The operation of tapping with a simple trocar and allowing the fluid to flow out through the cannula is no longer practised except in an emergency, when an aspirator cannot be obtained, or in an early stage of non-traumatic pneumothorax. An aspirator is a much better instrument.

Aspiration.—Aspiration consists in the introduction into the pleural sac of the tip of a hollow needle, the other end of which is attached by means of a rubber tube to a bottle from which the air has been exhausted. The fluid does not run out, but is sucked out, air is excluded, and bacteria do not enter the pleural sac. Fig. 379 shows a pneumatic aspirator. No anesthetic is required. The patient's skin, the instruments, and the surgeon's

<sup>\*&</sup>quot;Surg. Gynecol. and Obstet.," March, 1909. †"Annals of Surgery," November, 1896.

hands must be thoroughly asepticized. The patient is given a little whisky, and, unless he is very weak, he assumes a semi-erect attitude, with the arm hanging by the side. The trocar is introduced in the fifth interspace, just in front of the angle of the scapula. The surgeon marks the upper border of the sixth rib with the index-finger, and plunges in the trocar just above the finger, thus avoiding the intercostal artery, which lies along the lower border of the rib above. He guards the needle with the index-finger to prevent its going in too far. The fluid is withdrawn rather slowly in order that the patient may escape syncope and violent cough. If the patient becomes very faint, the operation should be abandoned. All the fluid present should not be removed at one sitting-complete removal of a large effusion is not safe. The operation can be repeated if necessary. After withdrawing the cannula place iodoform collodion over the opening in the chest. In an early stage of non-traumatic pneumothorax perform paracentesis without suction. In non-purulent pleuritic effusion, if the lungs will not expand after tappings. perform thoracotomy. In some cases aspiration is followed by pulmonary embolism or embolism at a distance. Syncope is a not unusual result. Convulsions occasionally occur. In rare cases the sudden withdrawal of a large effusion is followed by albuminous expectoration, as was pointed out by Pinault in 1853. It usually begins from a few minutes to half an hour after aspiration. When this complication arises, the pulse is very weak, there are severe dyspnea, cyanosis, cough, and the expectoration of quantities of a yellow, frothy fluid. Riesman ("Amer. Jour. of Med. Sciences," April, 1902) demonstrates that the condition is due to pulmonary edema and not to puncture of the lung. The sudden withdrawal of fluid by aspiration relieves the pressure which was compressing the lung, the lung becomes congested with blood (congestion by recoil, Riesman calls it), the blood distends weakened vessels, and profuse transudation takes place into the aircells. Most cases recover in a few hours or a day or two. Severe cases die from asphyxia. Terrilon collected 23 cases with 2 deaths. If albuminous expectoration arises, dry cup the chest and counterirritate with mustard plasters. Perform venesection. Give oxygen by inhalation. Administer atropin hypodermatically. Employ artificial respiration if neces-

Thoracotomy is an incision into the cavity of the pleura. It may be merely an intercostal incision, or may be an opening into the chest after resecting a portion of a rib. Often in a child with empyema good drainage can be obtained by an intercostal incision, but in most children and in all adults a rib should be resected. The instruments required for rib resection and thoracotomy are a scalpel, a grooved director, forceps (hemostatic and dissecting), scissors, a periosteum elevator, retractors, a costotome or

metacarpal saw, rongeur forceps, drainage-tubes, and needles.

If there is very little dyspnea, ether can be given. If there is considerable dyspnea, chloroform should be given. If there is severe dyspnea, no general anesthetic is admissible. In severe dyspnea the patient is using certain voluntary muscles to aid him in obtaining air. A general anesthetic abolishes the activity of the voluntary muscles of respiration, and so might cause suffication. In such cases the operation can be done with fair satisfaction after

the injection of eucain or after infiltrating the superficial tissues of the chest wall with Schleich's fluid, or, what is better, preliminary aspiration can be performed. Aspiration will permit of the subsequent administration of

a general anesthetic. The patient on whom thoracotomy is to be performed is placed supine, the diseased side being at or over the edge of the table. He must never be placed on the sound side, because he breathes only with that side,

and pressure on it may be dangerous.

The arm of the diseased side should be elevated to a right angle with the body. If the surgeon desires to obtain only intercostal drainage, he should make a longitudinal incision about three inches in length at the upper border of the sixth or seventh rib, and the middle of this incision should correspond to the midaxillary line. This incision is carried, layer by layer, to the pleura. If, as will usually be the case, he wishes to remove a portion of a rib, he will make an incision about three inches in length di-



Fig. 494.—Resection of a rib (Esmarch and Kowalzig).

rectly upon the outer surface of the rib he wishes to remove, and the middle of this incision corresponds to the midaxillary line. Some surgeons resect a portion of the fifth rib, some remove a bit of the eighth rib, and Munro\* shows that at the level of the eighth rib there is no danger of injuring the diaphragm. By many operators a portion of the seventh or eighth rib is removed in front of the line of the posterior axillary fold.

I agree with Hutton that a portion of the sixth rib in the midaxillary line should be removed.† The reasons given by Hutton for the selection of this rib are: (1) It is over the portion of the lung which expands last. An empyema is drained only partly by gravity, and the fluid is really forced out and the cavity obliterated by lung expansion. If an incision is made anterior or posterior to this point, the expanding lung will block the drainage-opening, and a pus-cavity without drainage will remain in the midaxillary line. (2) Such an incision permits a patient to lie on his back without mak-

ing pressure on the drainage-tube.

The periosteum of the outer surface of the rib must be divided in the same direction as the superficial incision. The exposed rib is stripped of Periosteum front and back by means of a periosteal separator, and with the periosteum at the lower border of the rib the intercostal artery is lifted out of harm's way. The rib can be divided by means of cutting forceps, a chain-saw, or a Gigli saw. I prefer a costotome, as it accomplishes the section most rapidly. The usual method is to push a periosteal separator under the rib, and saw the bone in two places by means of a metacarpal saw (Fig. 494). An inch or more of the rib should be removed. The intercostal artery is ligated at each end of the incision, the periosteum is removed, and the pleura is opened. The object of removing the periosteum is to prevent the rapid formation of bone which might narrow the opening and interfere with drainage. The actual opening of the pleura is carried out in the same way in intercostal incision and after rib-resection. A grooved direc-

Medical News, Sept. 2, 1899. †See W. Menzies Hutton on "Empyema," in Brit. Med. Jour., Oct. 29, 1898. tor is pushed into the pleural sac, and the opening is enlarged by means

of the forceps and the finger.

The finger removes all masses of tuberculous material or aplastic lymph within reach. If the finger finds the lung firmly bound down by dense adhesions so that it cannot expand, simple rib-resection will not cure the patient, and Estlander's, Schede's, or Fowler's operation should be done. Some surgeons advocate immediate irrigation after opening an acute empyema, but this procedure is unsafe. It is true that in most cases irrigation does no harm, but in no case will it sterilize the cavity, and in some cases it is very dangerous. The pleura is very susceptible to the action of irritants. This is especially true of young children. It happens occasionally that the injection of the blandest fluid is followed by intense dyspnea, great shock, disturbances of respiration and circulation, convulsions, and even death (Quénu). The convulsions which occasionally follow pleural irrigation were called by de Cerenville pleural epilepsy. In putrid empyema it is proper to irrigate. Irrigation will remove part of the actively poisonous putrid matter, and the retention of putrid matter is a greater danger than irrigation. It was formerly a common custom to make a counter-opening by cutting down upon the long probe pushed against the chest-wall after being introduced through the incision, but a counter-opening is of no particular use. A drainage-tube about two inches in length is introduced and stitched in place. The tube must not be long enough to touch against the lung. A safetypin is clamped upon the tube to keep it from slipping into the chest. A tape should be fastened to each side of the tube and tied about the chest to prevent it from slipping out. Arrest bleeding, suture the skin, dress with gauze, wood-wool, and a binder, and have the dressings changed as soon as they become soaked at one point. Several times a day change the patient's position. At each change of dressings direct him to lie on the diseased side with the foot of the bed raised for half an hour. Healing takes place by ascent of the diaphragm, expansion of the lung, and retraction of the chestwall. Expansion of the lung is favored by expiratory acts; hence cause the patient several times a day to blow through a rubber tube into a one gallon Woulff bottle filled with water. The water is blown into another bottle attached to the first by a tube. Remove the drainage-tube when the discharge becomes thin and scanty (about the eighth or tenth day, as a rule). If an empyema ceases to improve and remains stationary for months after it has been drained, firm adhesions exist. If after one year has passed a cavity still exists and there is a flow of pus, the surgeon must perform the operation of Schede, Estlander, Fowler, or Ransohoff.

Thoracoplasty (Estlander's operation) is employed in old cases of empyema in which drainage has failed, and in cases with retracted chest-wall, collapsed lung, thickened pleura, and cavities whose rigid walls will not collapse. The procedure recognizes the fact that after pus is evacuated, if the lung is adherent, it cannot expand to fill the space once occupied by fluid, and that the rigid chest-wall cannot fall in as a substitute for the lung. It seeks to destroy the rigidity of the chest-wall and to permit it to collapse and thus obliterate the cavity of the empyema. When the surgeon resects a rib and finds a cavity with uncollapsible walls, or a lung bound down with firm

adhesions, he should perform thoracoplasty. This operation causes the obliteration of the cavity by collapsing that portion of the chest-wall overlying it. The cavity is usually in the upper or central part of the pleural space. The instruments required are the same as those for resection of a rib. The

position is the same as that for ribresection. The length of the incision depends on the size of the cavity. The surgeonusually removes portions of the second. third, fourth, fifth, sixth, and seventh ribs. Make a transverse incision along the center of an intercostal space, and through this incision remove the ribs above and below by the method set forth on page 904 (the removal of six ribs will require three incisions). Instead of this incision, we can make a vertical incision or a U-shaped flap. Always take away the periosteum in order to prevent reproduction of the ribs. In cavities which are surrounded by firm adhesions, and inold cases in which the pleura is greatly thickened, irrigation is safe. If the cavity is small, it should be packed with iodoform gauze and allowed to granulate; if large, it should be drained by a large tube, the skin being sutured by silkworm-gut.

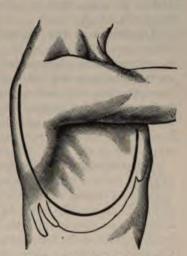


Fig. 495.—Incision for Schede's operation of thoracoplasty (Esmarch and Kowalzig).

Schede's Operation.—Schede showed that when the pleura is much thickened, even Estlander's operation will not permit the chest-wall to collapse and fill the cavity once occupied by the fluid. The instruments used are the same as for Estlander's operation. A U-shaped flap is made from the level of the axilla in front to the level of the second rib and between the scapula and spine behind. The lowest level of this incision corresponds to the lowest limit of the pleura (Fig. 495). The flap is loosened and raised and the scapula is lifted with it. The ribs from the second rib down and from the costal cartilages to the tubercles are removed, along with the intercostal muscles and the pleura. This is accomplished by cutting with boneshears and scissors. Hemorrhage is arrested. The pleura is cureted. A drainage-tube or a piece of iodoform gauze is introduced, and the raw hap is laid against the visceral layer of the pleura. The superficial incision is sutured, except at the point where the tube of the gauze emerges. The mortality from Schede's operation is from 15 to 20 per cent.

Total Pleurectomy or Pulmonary Decortication (Fowler's Operation).—In the spring of 1893 de Lorme performed some experiments on dogs looking to the development of the operation. In October, 1893, George Ryerson Fowler, having no knowledge of de Lorme's investigation, operated on a man and cured a chronic empyema. The French surgeon's first operation was months later. Extensive rib-resection is practised. This is better than de Lorme's trap-door flap, which causes pneumothorax. The thickened pleura is removed from the chest-wall, lung, pericardium, and diaphragm, any sinus is extirpated, and all granulation tissue is taken away. Fowler

maks a report of 30 cases. Eleven cases were completely cured. In 17 cases the empyema was cured, but 6 of them had tuberculosis. There were 3 deaths. The combined statistics of Fowler, de Lorme, and Cestan show 35.7 per cent. cured, 19.7 per cent. improved, 33.9 per cent. not cured, and 10 per cent. died (Kurpjweit, in "Beiträge zur klinischen Chirurgie,"

Bd. xxxiii, H. 3).

Discission of the Pulmonary Pleura (Ransohoff's Operation).—
This operation can be employed when decortication is impossible, and it
may be used as a substitute for decortication in certain cases. It is founded
on the observation that if the thickened pleura over a shrunken lung is incised
the cut widens with each respiration and quickly becomes a groove (Ransohoff, in "Annals of Surgery," April, 1906). The pulmonary pleura is divided
by numerous parallel incisions one-quarter of an inch apart, and then similar
incisions are made to cross these. An incision is also carried through the
costal side of the angle of reflection of the pulmonary and costal pleura.

Pneumotomy for Abscess of the Lung.—Give chloroform or use a local anesthetic. Place the patient recumbent with the shoulders a little raised. Make a U-shaped flap over the seat of disease. Resect a portion of a rib. If it is found that adhesions do not exist between the pulmonary and costal layers of the pleura, stitch these layers together with catgut and postpone further operation for forty-eight hours. If adhesions exist, proceed at once. Chloroform can be put aside when pleura is exposed. Fowler calls attention to the fact that lung tissue is so insensitive that the administration of an anesthetic can be suspended as soon as the pleura has been opened. Incise the agglutinated layers of the pleura, and pass an aspirating needle into the lung in various directions. When the abscess is located, open it with the cautery. Carry the Paquelin cautery slowly into the lung in the direction of the abscess-cavity. The cautery knife should be at a dull-red heat.

When the cautery opens the cavity of the abscess, withdraw the instrument and insert a drainage-tube, and suture the flap of superficial tissue. If the abscess is not found after one or two punctures with the aspirating needle,

abandon the attempt.

Tuffier explores for an abscess by what he calls décollement of the parietal pleura. He exposes the parietal layer of the pleura, passes his hand between this layer and the chest-wall, strips the pleura off over a considerable area, and is able to feel the lung below and thus determine its condition.

## XXVI. DISEASES AND INJURIES OF THE UPPER DIGESTIVE TRACT.

Injuries and Diseases of the Face, Nose, Mouth, Salivary Glands, Tongue, Jaws, and Esophagus.—Wounds of the Salivary Glands.—An aseptic wound usually heals and rarely results in a salivary fistula, although after healing it is not unusual for an encysted collection of saliva to gather under the skin. Such a collection of saliva, if it does not disappear spontaneously, can usually be gotten rid of by continued pressure. When a wound of a salivary gland is infected, a single fistula or multiple fistulæ may be left as a legacy. A salivary fistula is very annoying, because the saliva flows con-

Parotitis 900

stantly. A fistula usually heals spontaneously after a long time, but healing can be quickly brought about by touching the orifice with the Paquelin cautery.

Wound of Steno's duct is apt to cause a fistula, and the condition is often difficult to cure. In this condition, when the duct was cut across, the central end grows fast to the cutaneous surface. Fistula of Steno's duct may also be caused by obstruction and rupture of the duct and by suppurative or gan-

grenous processes.

In wounds of the duct the ends should be brought as near together as possible with catgut sutures which do not enter the lumen of the duct; an incision should be made through the mucous membrane to permit drainage of saliva, if the mucous membrane is not already opened, and the skin should be sutured. In some cases the central end of the duct may be carried into the

mouth and sutured to the mucous membrane. If, after an injury of Steno's duct, saliva gathers under the skin, make an incision through the mucous membrane, to give a route for the saliva to enter the mouth, and apply pressure externally. When a fistula forms, it may be cured by the cautery and pressure, but, if the peripheral portion of the duct is obliterated, which can

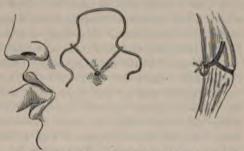


Fig. 496.—De Guise's operation for salivary fistula (Esmarch and Kowalzig).

be determined with a sound, an operation must be performed. Tillmanns advocates cutting out the external portion of the fistula by two elliptical incisions. A trocar is passed through the bottom of the wound in two places, about half a centimeter apart; a piece of stout silk is drawn through the holes and tied tightly and the superficial incision is closed. The silk cuts through and makes an internal fistula. Another method is to make an incision, find and isolate the central end of the duct, open the mucous membrane, suture the duct to it, and close the superficial wound.

De Guise's operation is shown in Fig. 496. He threads a piece of silk through two needles and carries the needles into the mouth so that the silk will embrace a bit of tissue half a centimeter in length. The silk is tied tightly within the mouth, the ends are cut off, and the margins of the fistula at the surface are freshened and sutured.

Parotitis.—Mumps, or epidemic parotitis, is treated by the physician. In this condition the submaxillary and sublingual glands are usually involved as well as the parotid. In pyemia metastatic abscesses may form in the parotid gland. Great swelling arises, respiration is often embarrassed, and early incision is necessary. Parotid inflammation other than mumps is usually due to the passage of bacteria up Steno's duct, the source of the microbes being a foul condition of the mouth, particularly noma or stomatitis. Hence such inflammation is most common during the existence of acute infectious diseases and sepsis. Suppuration or even gangrene may occur. As a rule, only one gland is attacked, but both may be. It is a well-known fact that occasionally,

though very rarely, after an abdominal operation inflammation of the parotid gland occurs. The condition is more common in adults than in children. This form of parotitis may, of course, be due to septic metastasis and may be produced by trauma, but I am satisfied that most cases result from foul mouths, the infection ascending from the mouth along the duct. Oral cleanliness strongly tends to prevent the so-called "sympathetic" parotitis. In about one-third of the cases the condition is not to be distinguished from mumps and is recovered from in seven or eight days. Mild cases seldom suppurate, and if they do, the pus flows down the duct and into the mouth. In nearly one-half of the cases, according to Marchetti ("Epitome of Surgery," in "Brit. Med. Jour.," March 6, 1909), there is phlegmonous inflammation with necrosis and suppuration of the tissues and formation of a salivary fistula. In non-suppurative parotitis there are pain, tenderness, obvious swelling, and hyperemia of the skin, and it is difficult to open the mouth or swallow. When suppuration occurs, all of the above symptoms are intensified, the discoloration becomes dusky, the skin becomes shiny and edematous, the constitutional symptoms of pus-formation exist, and there is usually delirium.

Treatment.—In the non-suppurative form apply an ice-bag over the gland for the first twenty-four hours and then substitute heat. Wash the mouth out frequently with an antiseptic wash and apply ichthyol and lanolin to the swollen region. In the suppurative form make several openings by Hilton's method, seeking for points of softening; apply hot antiseptic fomentations, wash the mouth frequently with an antiseptic fluid, and combat sepsis

by appropriate constitutional treatment.

Salivary Concretions.—The saliva contains in solution certain salts which may deposit. Deposited on the teeth, they constitute tartar. Deposited in a salivary duct or the acini of a gland they constitute a calculus. The salts deposited are carbonate and phosphate of lime. A calculus may consist purely of these two salts or there may be a foreign-body nucleus. A calculus is a possible result of an inflammation which blocks, constricts, or roughens a duct or acinus and decomposes saliva. Small concretions are often passed. Concretions the size of a bean are retained. A concretion may attain the size of an English walnut. A concretion does not block a duct continuously, but does so now and then, causing swelling and tenderness of the gland. A retained calculus can be palpated by a finger in the mouth and a finger externally.

Treatment.—A calculus in a duct is extracted by making an incision through the mucous membrane. If a very large calculus forms in the submaxillary

gland, the gland should be removed through an external incision.

Harelip and Cleft Palate.—Harelip is a congenital cleft in the upper lip due to defective development. Cleft palate is a congenital fissure in the soft palate or in both the hard and soft palates. In harelip the cleft is usually complete, through the entire lip into the nostril, but in rare cases it may show only as a furrow in the mucous edge or as a split from the nostril partly into the lip. It is most common on the left side. In double harelip the central portion of the lip is often adherent to the tip of the nose. Double harelip may be free from complication, but is often associated with a malformation of the alveolus and palate. Median harelip is exceedingly rare. In cleft palate the septum of the nose is usually adherent to the palatine process.

opposite the side upon which the fissure exists. In those rare cases of cleft palate double in front, the nasal septum is attached only to the premaxillary bone, and the premaxillary is not attached at all to the superior maxillary bone. In harelip there is frequently a cleft in the alveolus, and almost always flattening of the corresponding side of the nose. Harelip is often associated with cleft palate, talipes, and other deformities. It is a great deformity, and interferes with sucking, swallowing, and articulation.

Operation for harelip uncomplicated by cleft palate should be performed between the third and sixth months of life in a child in good health, free from stomach trouble, cough, or coryza, but operation is not advisable in the early weeks of life. Always, if possible, operate before dentition begins (seventh month). If the child is in poor health, postpone the operation until restoration has so far advanced as to render operation safe. While waiting for operation be sure the child is getting enough food. If it cannot suck, feed it with a spoon. If a cleft exists in the palate, we sometimes operate first upon the lip, because the pressure of the parts after the edges of the gap are approxima ted aids in the closure of the bony cleft. In other cases we operate first on the palate. Cleft palate interferes with sucking, deglutition, mastication, and articulation. In severe cases the food passes into the nose and excites inflammation. Loss of control of the palate-muscles always exists, and liquids and solids are liable to pass into the windpipe. Clefts in the hard palate should not be operated on until the second year, but should be operated upon then, otherwise speech will be permanently affected. Some surgeons refuse to operate until the tenth or twelfth year, but operation done this late will not correct speech-defect. The patient at the period of operation should be well and free from cough. In many cases the passage of food and drink into the nose can largely be prevented by the use of a diaphragm.

Operation for Harelip.—The instruments required are a tenotome and scalpel, toothed forceps, hemostatic forceps, scissors curved on the flat and pointed, straight blunt-pointed scissors, needles (straight and curved), silver wire or silkworm-gut and silk sutures, a mouth-gag and tongue-forceps, a needle-holder and sequestrum-forceps, each blade protected by a rubber tube. Wrap the child in a sheet; place it in the Trendelenburg position, and rest the head upon a sand-pillow. The surgeon stands to the right side of the patient. Ether or chloroform is given. For single harelip, separate with the scissors the upper lip from the bone on each side of the cleft until approximation of the cleft can be effected without tension. If the premaxillary bone of one side projects more than its fellow, grasp it with sequestrum-forceps and bend it back (Jacobson and Treves). Clamp the upper lip at each angle of the mouth to prevent hemorrhage. If the edges are of equal or nearly equal length, and if the gap is not very wide, perform Malgaigne's operation. This is performed as follows: a flap is detached on each side, the detachment beginning at the upper angle of the gap; each flap is detached above, but remains attached below. The flaps are separated from the bone, and are drawn downward so as to form a prominence at the vermilion border (Fig. 497). If the edges are pared so that in closure the vermilion border is even, when the parts are healed a gutter will be visible at the line of union. The edges are approximated by an assistant, and silkworm-gut sutures or silver wires are passed by means of a straight needle. Each suture goes down to the mucous membrane. The first suture is passed through the middle of the lip, one-third of an inch from the cleft. Three or four main sutures are passed through the thickness of the lip, and are tied and cut off. Two or three fine silk or catgut sutures are passed by a curved needle through the vermilion border of the lip and the mucous membrane of the mouth, and are tied and cut off. A small piece of gauze is placed over the lip and is held in place by straps of rubber plaster. After operation prevent the child crying by feeding it often and giving it small doses of laudanum. Heath orders two drops of laudanum in one ounce of distilled water, a teaspoonful to be given every two or three hours. About the sixth day one-half the sutures are taken out, and on the eighth or ninth day the remaining ones are removed. In many cases no further procedure is necessary, but if after some weeks the prominence at the lip-border does not shrink, it can be readily clipped away. Harelip-pins are not used at the present time, and are not needed if the lip is well separated from the bone. If the edges of the cleft are of unequal length, Edmund Owen's operation can be performed (see



Fig. 497 —Malgaigne's operation for harelip.



Fig. 498—Incisions for double harelip (Esmarch and Kowalzig).



Fig. 499.—Mirault's operation for single harelip (Esmarch).

below, under Double Harelip), or we can perform Mirault's operation, as shown in Fig. 499.

In double harelip the operation is similar to that for single harelip. If the intervening piece is vertical and is covered with healthy skin, complete each operation as for single harelip, closing both fissures at once with silver wire in a strong, healthy child, closing them at intervals of three weeks in one not so lusty (Fig. 408). Excise the septum if it is deformed. The premaxillary bone should in most instances be removed, the skin over it being preserved. Wm. Fergusson was accustomed to incise the mucous membrane and shell out this bone. The premaxillary bone can be forced back into line, being held, if necessary, by catgut suture of the periosteum; but if saved, it is liable to necrose and its teeth soon decay. Heath removes this bone two weeks before operating on the lip. If there is much hemorrhage after removal of the bone, arrest it with a hot wire or with Horsley's wax. Fig. 498 shows incisions for double harelip. Edmund Owen's operation is very useful (Figs. 500 and 501). In this operation very thick flaps are cut. The prolabium and incisive bone are removed. The flaps are cut as shown in Fig. 500, on one side by a line ab, and on the other side the piece cde is removed; a is brought to e, b is brought to d, f is brought to c, and sutures are applied (Fig. 501).

Operation for Cleft Palate.—It is true that during the early years of its growth a cleft diminishes in size and particularly if a harelip is closed; but to wait too long before we operate means permanent speech impairment. Bony clefts should be operated upon early in the second year. Clefts of the

soft palate only may be operated upon during the first six months of life. If both the hard and soft palates are cleft, close both at one operation. In an ill-nourished child in which the covering of the bone is obviously thin, it is best to postpone any operation upon a bony cleft until the end of the third year. I agree with Berry that operation is justifiable up to the age of twenty, but early operation is highly desirable. Edmund Owen has recently put forth a convincing plea for early operation.\* He says he is operating earlier and earlier, and quotes Chilton as the gentleman who led him to do so. Owen maintains that if speech is to be improved, operation must be done early, and he formulates some very valuable rules for preparation and care. I have never been convinced that operation in early infancy is entirely safe and has any notable advantages. When one comes to treat congenital clefts of the lip, the alveolar process, and the hard and soft palate, the necessities one should seek to obtain are the surgical closure of the clefts, the establishment of the function of the involved tissues, the correction of the congenital deformity, and the prevention of postoperative or acquired deformity. There are few if any cases of cleft palate that cannot be successfully treated by surgical



Fig. 500.—Double harelip, the prolabium and incisivebone having been removed (Owen).



Fig. 501.—The two sides of the lip drawn together and secured by sutures (Owen).

means; and it is a very unusual thing for a case really to need any mechanical appliance, such as the obturator and velum.

In deciding upon the time for operating and the nature of the operation, the safety of the patient should be the first consideration. One must carefully consider his physical condition, especially with respect to nutrition. An operative method that has a greater mortality than is incident to minor surgery ought not to be selected, and no operation should be performed until the condition of the patient justifies it. Having considered the physical condition of the patient and the relative safety of different operative plans, a careful study of the individual case should be made; and in this study each of the lour requirements above set forth must be attentively regarded. If we succeed in closing the cleft without establishing the function of the tissues, without correcting congenital deformity, and without preventing postoperative or acquired deformity, we leave the patient worse off than he was before, and perhaps renders subsequent satisfactory treatment impossible.

We should attempt to secure closure of the cleft with the least possible formation of cicatricial tissue. The simplest technique is the best, and we should endeavor to avoid all additional traumatism, such as incisions to re-

lieve tension and to permit of approximation. One should refrain from passing additional approximation-sutures, from bruising the tissues by overtension or by traction-forceps, and from using large needles and coarse suture materials, which make large suture-cicatrices. The amount of scar tissue bears directly upon the functional result. In addition, when dealing with the lip, and especially with the soft palate, one must seek to avoid incisions that involve muscles, and particularly the nerve-supply of muscles.

The periosteal-flap operation separates portions of the soft palate from the palatine bones. A large amount of cicatricial tissue is necessary to effect repair, and this mass of new tissue lessens the good functional results. In the periosteal-flap operation the repaired soft palate is anterior and inferior to the position secured by the osteoplastic method and, to that extent, interferes with the closure of the nasopharynx. Nevertheless, in my opinion, the operation which uses the soft tissues only is by far the safest and is the one I usually employ. In cases of complete cleft associated congenital deformities are

especially manifest in the nose, lips, premaxilla, and maxilla.

To correct congenital deformities and to prevent postoperative or acquired deformities is the most neglected and the least understood phase of the subject; and it is a very complicated question to hope to make clear in a brief statement. The key to the difficulty is the normal contour of the face as established by the proper occlusion of the permanent teeth. In finding this out there is no better guide than the rules laid down by Dr. Angle in the latest edition of his Orthodontia. He maintains that every tooth must be held in its proper relation and occlusion; and that if any teeth are lost they must be replaced in order to establish or restore the proper expression and contour of the face. To comply with the foregoing requirements one should avoid any operation that would not maintain or would fail to replace the normal position of the premaxilla and the maxilla and their future complement of teeth. If the premaxilla is only slightly in advance of its normal position, the early closure of the cleft of the lip will help to replace it. If, however, the premaxilla is far in advance of its normal position, it is hopeless to expect the pressure of a reunited lip to restore it to position. In such a case sufficient of the nasal septum posterior to the premaxilla must be resected, and the premaxilla must be carried back and sutured in position; but this operation should be done after the closure of the cleft soft and hard palates, and seldom at the same operation. If the cleft is unilateral in relation to the premaxilla and that bone is swung to the opposite side, and anterior to its normal position, the pressure exerted by an early repaired lip will often correct the condition. Until the deciduous incisors have erupted it is difficult to determine how far the intermaxillary bone really protrudes; and it is often surprising to observe how little correction is needed in what had appeared to be marked protrusion of the premaxilla in a unilateral or bilateral cleft. I in doubt about this point it is better to wait until the eruption of the deciduous incisors, when one may decide with certainty whether there is enough anterior protrusion to warrant the closure of the lip before operation on the palate. Early closure of the cleft of the lip brings very considerable pressure to bear, especially in double cleft or the typical harelip, as the lateral portions are comparatively short and the lip is usually quite tense. Sometimes this pressure is quite efficient, when exerted upon these cases of protrusion of the

premaxilla, which are frequent, and of lateral separation of the maxillæ, which are infrequent; but when such pressure is exerted upon cases without protrusion or separation, it produces an unfortunate postoperative deformity, and one that is too frequently encountered. It causes the alveolar arch to lose its parabolic curve, and what should be an arch is frequently V-shaped or triangular, and not infrequently the cuspid teeth are closely approximated. One thus gets marked flattening of the anterior lateral region of the face or cheek, with loss of contour and position of the upper lip and apparent protrusion of the lower lip and chin. It is true that such a postoperative deformity can be corrected by modern orthodontic methods, but it is better to prevent it than to be obliged subsequently to correct it.

From the preceding remarks it is evident that it is to be regarded as advisable in many cases to close the cleft in the soft and hard palates before operating upon the lip. The best time for operating is just before the patient begins to employ articulate speech. In most cases the cleft in the alveolar process, including the floor of one or both nares, should be repaired separately, and subsequently to the repair of the hard and soft palates. A comparatively short time after operating upon the palate the lip may be repaired; and the lip also should be repaired before the establishment of articulate speech. An advantage in operating with the harelip still unclosed is that one can see better and work better during the operation on the palate, and can give the palate better local care after the operation. Unfortunately, however, many children with cleft palates are never brought for advice until they have cultivated articulate speech. It is always very difficult and often impossible to correct the manner of speaking that they have taught themselves. Only long training and much perseverance is of any avail. The earlier the operation is performed, the better will be the result-not only from the functional standpoint but also as regards the correction of existing deformity and the prevention of future deformity. So far as obtaining good surgical results go, there is practically no set age limit.

If operation is refused for cleft of the hard palate, if it offers no real hope, or if it is very dangerous, an obturator must be worn. An obturator is made by a dentist. In preparing a child for operation I follow Edmund Owen's rules, viz.: Have the child in the best condition, free from cough and stomach disorder. Operate in summer. Place the child under the charge of

a nurse several days before the operation.

Operation for Suture of the Soft Palate (Staphylorrhaphy).—The operation of staphylorrhaphy, which is applied to clefts of the soft palate alone, is a comparatively easy procedure. In performing this operation the patient should be anesthetized and be placed in the Trendelenburg position, or else with the head hanging over the end of the operating table. The mouth is held open with Whitehead's gag, and an assistant holds an electric light and a reflector to illuminate the oral cavity. If the patient is not a young child, the operation may be done under cocain, with the subject sitting erect in a chair and the surgeon sitting directly in front of him.

The surgeon should have at hand several knives of different shape. The double-edged, pointed knife is an excellent one for freshening the margins of the palate. Special forms of needle-holders have been devised for the purpose of carrying the needle. The heavy, curved, sharp-pointed bistoury is the best instrument for dividing the muscles of the palate; and a

sharp hook should be at hand, in order to catch the edge of the necessary.

The surgeon first of all separates the soft palate from the posteri

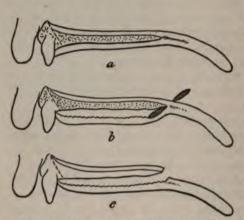


Fig. 502.—Longitudinal vertical section through the hard and soft palates. a, Before operation. b, Palatine mucoperiosteum detached and brought down. Blades of scissors introduced to cut attachment of soft palate to the bony palate and to the nasal mucous membrane. c, The same after the cut has been made and the soft palate thus brought down (Berry).

of the palate bones and f nasal mucous membran 503). This step is neces order that the edges may the middle line (Berry) edge of the cleft uvula grasped with a pair of for a sharp hook, and is pulle to make it tense. This then pared from below a the piece being continuou the base to the apex cleft. This piece is seven then the other margin cleft is pared in the sam It is now advisable to fi margins of the wound fro sion. These lateral incisi only relieve tension, but t arily paralyze the soft Figs. 503 and 504 show cisions as recommende

Berry. These incisions divide the tendons of the levator palati a palatopharyngeus muscles, and temporarily paralyze the palate. The

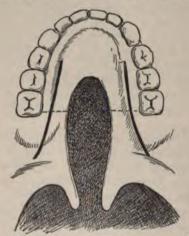


Fig. 503.—Cleft of soft and part of hard palate. Shows exact situation in which the lateral incisions should be made (Berry).



Fig. 504.—Semi-diagrammatic view of left cleft palate. The septum nasi is at the palate on the (patient's) right side. cot's membrane on the left side of the septe detached and brought down if nechelp in the closure of the anterior half of Shows exact situation in which the lateral should be made (Berry).

ment of palate function is not permanent, as the nerves to the muscles are not cut.

The sutures are inserted by means of a special needle-holder, so arranged that the needle may be directed in many different positions when grasped. The sutures are introduced from below upward, silkworm-gut being used for the uvula and the lower part of the velum, and silver wire for the balance of the cleft. Each suture, as it is passed, is so tied or twisted, and it is not cut off until the next suture is inserted, and thus serves as a handle. If there is too much tension to allow of the sutures being tied as they are inserted, all

the sutures are passed and lightly twisted before one is tied.

Closure of Clests in the Hard Palate (Uranoplasty).—As previously stated, the best time to perform these operations is during the second year of life. In some few cases we postpone the operation until the end of the third year. If the child learns to talk with the palate cleft, articulation will never be very greatly improved, even by operation. One should, therefore, try to operate before the child learns to talk. Even after the closure of the cleft the speech does not become entirely normal; in fact, as Berry says, it never becomes even very good. One should exercise the greatest care in forming the soft palate, because good articulation is largely dependent upon a well-formed soft palate (Berry, in "Brit. Med. Jour.," Oct. 7, 1905). The surgeon may be able to close the entire gap at one operation; or, owing to undue tension, he may be forced to close it but partly, completing the closure at some subsequent period.

The operation that, to my mind, is the best is one that uses the soft tissues alone—such a one as is advised by Berry. I have entirely abandoned the operation of wedging the bone over with a chisel. I am satisfied that it is far more dangerous than is the other method; it is more liable to fail; and, if it fails because of necrosis, it is difficult or impossible to cure the defect by a second operation. The essence of a successful operation, using the soft tissues alone, is, as Berry insists, the complete detachment of the soft palate from the posterior edge of the palate-bone (Fig. 502); because, if one fails to secure this, the edges of the gap will not approximate in the median line. One should also separate the soft palate from the mucous membrane

of the nose (Fig. 502).

A second very important point is the imperative necessity of making incisions to the sides, to relieve tension, and to paralyze for a time the soft palate. The incisions, as recommended by Berry, are shown in Figs. 503 and 504. The cut is close to the teeth, and is taken as far posterior as the middle of the soft palate, at the junction of that structure with the lateral pharyngeal wall. In this cut there is some risk of dividing the anterior palatine artery; but hemorrhage from this vessel can be arrested by pressure. Berry insists that the incision need not go forward more than the level of one or two premolar teeth; or, in older children, to the first or second molars. The edges of the fissure are pared on each side, from the tip of the uvula to the top of the gap. Strips of the mucoperiosteum are lifted up on each side of the gap and shifted toward the cleft, and at this stage the posterior border of the soft palate is separated from the posterior border of the soft palate is separated from the posterior border of the hard palate (Fig. 502).

The parts are sutured with silver wire, following the advice of Edmund



allowed to remain between two and three weeks.

Fergusson's Operation.—In this operation the mucous edge the bones are drilled for wires, and the sutures are inserted, but incision is made on each side of the cleft down to the bone, each i midway between the cleft and the corresponding alveolus. divided on each side, by means of a chisel, to the full length of and the chisel is used as a lever to force each half of the bone to The sutures are tied, and each lateral incision is plugged with iod

Brophy's Operation.—This operation is employed particularl under three months of age, and cannot be used when the child is ov. In this operation the palate is closed before the harelip is touch ing at this time, the bones are soft, and by leaving the harelithe surgeon has more room to work. The author of the operathat when it is performed at this early age the palate-muscles do but develop, and that the patient does not form the evil habit of tal the nose.

In performing this operation the very strong-handled needle are necessary. The patient is anesthetized and put into the T position and a strong piece of silk is put through the tip of the traction-suture. The edges of the cleft in the hard palate are ; of the bone being taken away with the paring. Then the edges the soft palate are pared. The needle is threaded with strong si is lifted; and the threaded needle is forced through the super bone from without inward, starting just back of the malar pro above the palate. As the needle shows in the cleft the thread with a pair of forceps, and the needle is pulled out, the loop of th ing in the cleft. Through a part of the opposite superior m responding with this first point of entrance the needle is enter another loop is got into the cleft. The second loop is caught loop, and when the former is pulled out, it carries the latter w thread now passes through both the superior maxillary bones through the nasal septum as well. This thread is used to pull a p One other silver wire is introduce cilron wine through

deem it advisable to wait one day before doing so. After the palate heals the

harelip is closed. Carcinoma of the Lower Lip.—Cancer commonly arises in the lower lip, very rarely in the upper lip. Males suffer frequently, but females are not very often attacked. In some cases it seems to arise in smokers at the point on the lip where the pipe habitually rested. A short-stemmed clay pipe, which grows hot when it is smoked, is particularly apt to lead to the growth of cancer. The region of the lip which is most liable to cancer is the junction of the skin and mucous membrane. The growth may begin in a fissure or abrasion, may start in an eczematous area, but most frequently arises as an indurated area which quickly ulcerates. After a cancer has existed for a variable time the submental and submaxillary lymphatic glands become diseased. These glands are always involved within three months of the beginning of the cancer. In a case of my own they were found to contain carcinoma cells in less than three months after the origin of the carcinoma of the lip. This involvement cannot be detected by external manipulation in the earliest stages; hence it is not proper to conclude that the glandular involvement is absent simply because it cannot be palpated. It occasionally happens that glands enlarge because of septic absorption, and this enlargement may even precede carcinomatous involvement. From an operative point of view the glands should always be regarded as carcinomatous. If cancer is not operated upon, it destroys the lip, involves the glands of the neck extensively, the floor of the mouth, the periosteum and the lower jaw, and produces death in from three to five years. If the jaw is involved, the prognosis is bad and it is practically hopeless if the floor of the mouth is involved.

Treatment.—The treatment consists in the early and thorough removal of the growth with the knife, and also in the removal of the fatty tissue and gland from the submaxillary triangles and from the submental region. The growth must be thoroughly removed—that is, the incision must be at least half an inch wide of the disease. For many years a favorite operation has been the Vshaped incision, the skin-edges being sutured by silkworm-gut, the sutures being passed almost to the mucous membrane and being inserted so as to compress the vessels when tied, and the mucous membrane being sutured with fine silk or catgut. The V-shaped incision should be used only for a very small and very recent growth. After the removal of the growth from the lip a vertical incision is made from the point of the V over the cricoid cartilage, and from the origin of this incision incisions are made in each direction along the under surface of the body of the jaw. The glandular area is thus exposed, and after the removal of the fat and glands the wound is sutured with silkworm-gut. Far better than the V-shaped incision is the operation devised by W. W. Grant, of Den-Ver.\* In this operation the growth is removed and cheiloplasty is performed.

Grant's Operation for Cancer of the Lip.—This operation gives a useful mouth and a more natural-looking lip than does the ordinary operation, and there is decidedly less tension on the suture-line. Furthermore, the suture-line in a man is soon covered with a beard. The procedure has great advantages over the ordinary V-shaped operation, which greatly lessens the size of the mouth, making it what is known as a sucker-mouth; and the new lip is rigid and ugly.

<sup>\*</sup> Medical Record, May 27, 1899.

In Grant's operation two vertical incisions are made, one on each side of the growth, and these are connected with a horizontal incision at the base (Figs. 505 and 506). Thus, a quadrangular gap is formed, which must be filled by flaps. An incision is made on each side from each inferior angle of the wound, obliquely downward and backward beneath the maxilla, on a line about midway between the angle of that line and the apex of the chin (Fig. 505). Its further extension is determined by the amount of lip removed and by the degree of glandular involvement.

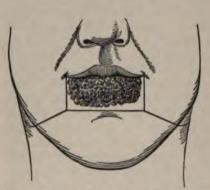


Fig. 505.—Grant's method for removal of carcinoma of the lower lip. The incision.



Fig. 506.—Grant's method for removal of carcinoma of the lower lip. Second step. The mass removed.

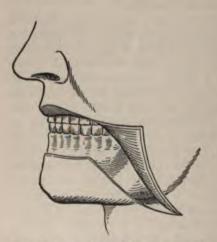


Fig. 507.—Grant's method for removal of carcinoma of the lower lip. Dissection preliminary to suturing.

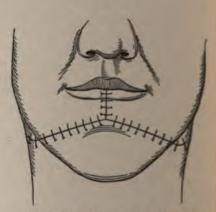


Fig. 508.—Grant's method for removal of carcinoma of the lower lip. The wound sutured.

The submaxillary lymph-glands are removed through these incisions. The glands in the midline, however, beneath the chin may require a separate incision. If the lip is extensively involved, the cheek ought to be completely separated from the inferior maxillary bone to the middle of the masseter muscle (Fig. 507). When the glands have been removed, the triangular flaps are

Ranula 921

brought together and united, first of all, in the middle line (Fig. 508). If the tension is marked, owing to the amount of tissue excised, it is wise to insert a traction suture, three-quarters of an inch from the center line, and tie it over pads of gauze covered with muslin. One thus prevents undue tension upon the sutures in the center of the flap. The stitches that unite the cheek posteriorly are inserted and tied, and the entire thickness of the cheek must be included. Silkworm-gut sutures are used. A drainage-tube is inserted in the posterior angle of the wound on each side. It is very useful to use also a T-drainage-tube as advised by Grant. This tube is about the diameter of a lead pencil and the cross-piece rests behind the incisor teeth or symphysis and beneath the tip of the tongue. This tube drains away all of the mouth secretions, saves the lines of incision from being constantly bathed in them, and renders very frequent changes of dressing unnecessary.

I have employed this operation repeatedly, and regard it as the most useful method we have for the purpose. Thorough removal of the carcinoma of the lip and of the related glands will cure from 60 to 70 per cent. of cases.

Carbuncle of the Upper Lip.—In contrast to carbuncle in other regions of the body, facial and lingual carbuncle is most common in young persons. The condition is due to staphylococcus infection and begins as a papule. Numerous pustules appear, and sloughing usually takes place. There may or may not be serious constitutional involvement. The condition is very dangerous, as thrombophlebitis may arise and track up into the cranium. I have known two persons to die from carbuncle of the lip.

Treatment.—Make a crucial incision, cutting away the corners and edges with scissors. Scrape out the carbuncle with a sharp and strong curet, swab with pure carbolic acid, pack with iodoform gauze, and dress with antiseptic Poultices.

Tongue-tie (congenital ankyloglossia or adherent tongue) is a congenital shortness of the frenum, the tip of the tongue adhering to the floor of the mouth. It is due to the projecting portion of the tongue being incompletely developed from the tuberculum impar. "In many of the slighter cases the development has merely lagged behind, and will be completed as the child grows after birth" ("Diseases of the Tongue" by Henry T. Butlin. Second edition). The tongue cannot be protruded beyond the incisor teeth. Swallowing is interfered with, and later in life articulation is impeded. It is not Very unusual in infants, but in the great majority of cases disappears as the child grows older. Persisting tongue-tie, Butlin says, is one of the rarest of conditions, and my experience is in absolute accord with this-in fact, I have never seen a single case. Many unnecessary or even harmful operations e done for a condition which, if let alone, will usually correct itself. Im-Proper operation may result in fatal hemorrhage or in "swallowing of the Ongue." The operation usually done is to tear up the frenum with a thumb-This is unsurgical and makes a lacerated wound. A better way is to aise the tip of the tongue to make the bands tense, and then snip with the Scissors close to the mucous membrane of the lower jaw. The slit in the handle of the grooved director was placed there to catch the frenum in, but a short frenum will not enter it (Butlin).

Ranula is a retention-cyst of the duct of the submaxillary or the duct of the sublingual gland. A ranula when first formed contains saliva, but after a

time the saliva undergoes a change, and in appearance comes to resemmucus. Mucous cysts occur in the floor of the mouth, resulting from obstrtion of the ducts of the mucous glands of Nuhn and Blandin. These glarlie on each side of the frenum of the tongue. Such a cyst is often spoken of



Fig. 509.-Ranula.

a ranula. A cyst of the incisive glaforms just back of the lower ja and lifts up the frenum. A tru ranula appears upon the floor of the mouth on one side and pushes the tongue toward the opposite side The treatment of a mucous cyst is by excision of a portion of the cyst wall and cauterization of the interior with pure carbolic acid; or by cutting a flap from the cyst-wall and stitching it aside so as to keep a permanent opening. Such an operation may cure a genuine ranula, but will often fail. In true ranula an external incision should be made, and

through this both the cyst and the gland should be removed. This plan is recommended by Mintz.\*

Thyrolingual or Thyroglossal Cysts and Sinuses.-In early embryonal life the thyroid gland has a duct which passes from the thyroid isthmus to the foramen cæcum of the dorsum of the tongue. The duct may be lined with one layer, two layers, or several layers of epithelium, and there are mucous glands and lymph-follicles in its walls, these structures being derived from the mucous membrane of the tongue. The wall of the duct presents numerous irregularly placed and irregularly shaped diverticula. It is known as the thyroglossal or thyrolingual duct. The duct runs from the base of the tongue down the mid-line of the neck. It is connected with the body of the hyoid bone, with the periosteum in front of the bone, and with the thyrohyoid bursa behind the bone. It passes to the upper portion of the front surface of the trachea, where it bifurcates, each branch passing to a lateral lobe of the thyroid gland. This fetal structure under normal conditions begins to atrophy in the fifth week and closes by the eighth week, the foramen cecum marking its old orifice on the dorsum of the tongue. When the duct is obliterated, it becomes a cord of epithelium. In more than 30 per cent. of bodies the remains of this primitive passage can be found (Weglowski, in "Zentralb. f. Chir.," 1908, xxxv, 289). The duct may persist between the foramen cecum and the hyoid bone, developing, it may be, into a sublingual dermoid. The portion behind and below the hyoid may remain and develop into a subhyoid cyst. The part inferior to the hyoid may persist, give origin to a cyst which ruptures and constitutes an incomplete median cervical fistula. The duct may remain open from the mouth and make, by bursting an opening in the neck, a complete median cervical fistula. A patent duct may exist for years and announce its existence by some acute inflammatory process. The small diameter of a cervical fistula renders probing to any depth impossible. Some have told us to determine if a fistula is

\* Zeitschrift für Chirurgie, March, 1899.

complete by injecting quassia solution into the lower end. The patient will perhaps experience a bitter taste. If we inject a colored fluid we may see it if it runs from the mouth. I have never succeeded in doing either. Tumors may spring from the duct.

Treatment.—If a thyroglossal cyst or tumor arises on the dorsum of the tongue and if it is increasing in size and interferes with swallowing and speech, must be removed through the mouth. A general anesthetic should be given.

In some cases preliminary tracheotomy is necessary.

A cyst, tumor, or fistula about the hyoid bone requires excision, the patient being under the influence of a general anesthetic. A portion of the cyst-wall adheres strongly to the posterior surface of the hyoid bone and must be carefully removed even if it is necessary to split the bone to accomplish it. In treating fistula the surgeon makes an elliptical incision of the skin about its orifice so as to free the fistula from the subcutaneous tissue. When traction is made upon the cutaneous end of the duct it will stand out clearly and can be dissected out (M. S. Seelig, in "Surg., Gynecol., and Obstet.," May, 1907). It is useless to try to cure a fistula by cauterization. A fistula requires the complete removal of its epithelial-lined walls. No lesser operation will cure. In one case I operated four times before securing success. In a recent case I divided the bone, removed the fistula, and sutured the bone with chromic gut.

Carcinoma of the Tongue.—This is one of the most dreadful forms of cancer. It is quite a common disease. In most of the cases I see it is far advanced when first brought to the surgeon. The only form of cancer which attacks the tongue is epithelioma. It is much more common in men than in women. It is a disease of adult life and is very rare before the age of thirtyfive. It begins, as a rule, near the tip, on the side or at the base of the anterior two-thirds of the tongue, as a warty growth, as an ulcer having at first a papillary structure, as a fissure which indurates, or as an indurated area which ulcerates. The cause of the growth may sometimes be traced to the irritation of a jagged tooth, or to the smoking of a pipe, or to holding nails in the mouth, as is done by those who nail laths. Cancer may follow a chronic inflammation-leukoplakia, for instance. Chronic ulcers are liable to become cancerous and any indurated ulcer has potentialities of peril and should be promptly removed. Fournier regards syphilis as an influential cause and states that in 184 cases of cancer of the mouth or tongue 155 had had syphilis. There has been no such proportion of syphilitics in my personal cases. In Whitehead's 104 cases only 7 had had syphilis. As in cancer of the lip, men are much more frequently affected than women. In most cases the disease spreads rapidly; produces early and extensive glandular involvement; disease of the floor of the mouth; dribbling of saliva; difficulty in masticating, swallowing, and talking, foulness of the breath; severe pain which usually radiates toward the ear, and often a fatal septic trouble. Cases not operated upon usually die within two years. There is a very rare form of carcinoma described by Wölfler, which grows very slowly or even remains latent for years.

One reason why cancer of the tongue grows so rapidly has been pointed out by Heidenhain, of Greifswald. The lingual muscles are contracting almost constantly, and as a result cancer-cells are forced along the lymph-spaces to

healthy areas.

Treatment.-A cancer of the tongue should be removed radically at the

tion the teeth should be scrubbed twice a day with a brush and mouth rinsed with hydrogen peroxid. The nares and nasoph be sprayed with peroxid of hydrogen and then with boric acid s second or third hour when the patient is awake.

In this disease not only the tongue but also the adjacent lym must be removed. Cancer of the tip of the tongue, as a rule, firs submental and sublingual group of glands. Cancer of the anter of the dorsum of the tongue first involves the lingual and subman nodes. Cancer of the under surface of the tip of the tongue the submaxillary glands. Sooner or later the superior deep ce about the carotid bifurcation become involved in cancer of the the anterior portion of the tongue. In cancer of the dorsum the glands become involved as well as the superficial nodes. To system of the base of the tongue is distinct from that of the balance It drains into the deep cervical groups.

It was my belief until recently that in a very recent and limi the glands on the diseased side require removal, but that in case the glands must be removed from both sides of the neck. has convinced me that in any case the glands on both sides moved. Kuttner, of Tübingen, has demonstrated that lymp side of the tongue may flow to glands on the same side of the ne also may flow to the opposite side of the tongue. Remove I involved glands by the "block dissection" of Crile. In a bad ca is removed but the carotid arteries. The sternocleidomastoid omohyoid, the jugular vein, even the pneumogastric and phrenic side may be taken away. After a week or two the other side of the be operated upon. It seldom requires a wide removal of struct pneumogastric or phrenic were cut on one side they must be pres other. The jugular can be removed after a collateral circulation tablished subsequent to removing the jugular of one side. are to be considered: partial removal and complete removal.

Partial Removal of the Tongue.—This operation is restricted to

Split the tongue back in the middle line with the scissors, and loosen the cancerous side from the floor and side of the mouth. Pass a stout silk ligature through the base of the tongue posterior to the cancer. Draw the organ out and cut off the diseased side in front of the ligature but back of the disease. The the vessels, remove the constricting and traction threads, and treat sub-

sequently as in cases of complete removal.

Complete Removal of the Tongue (Kocher's Method).-Kocher recomends a preliminary tracheotomy in tongue-excision, but the Trendelenburg position renders this procedure unnecessary so far as fear of the passage of blood into the larvnx and trachea is concerned. The instruments required are scalpel, retractors, a dry dissector, hemostatic and dissecting forceps, a tenac-1 um, aneurysm-needle, tenaculum forceps, needles, sutures, and scissors. In this operation the patient is placed in the Trendelenburg position, the surgeon standing to the side. Ether or chloroform is given. Ligate the lingual artery on the side opposite to the one where the main incision is to be made. Remove the glands on that side and suture the wound. An incision is then ande on the side opposite to that on which the artery was ligated. This incision passes from behind the lobe of the ear, along the anterior edge of the sternocleidomastoid to about the middle of the margin of this muscle. From this point the incision is carried to the level of the hyoid bone and then to the mphysis menti, along the anterior belly of the digastric muscle (Fig. 510). The flap is dissected and turned up; the facial and lingual arteries are ligated; the submaxillary fossa is evacuated" (Treves); the sublingual and sub-

brane is incised close to the jaw, and the tongue, caught with tenaculum-forceps, is drawn through the opening. The tongue is split in the middle with scissors, and the near half is removed, bleeding is arrested, the remaining half of the tongue is cut through, and the vessels are tied. Stitch the mucous membrane of the stump to the mucous membrane of the floor of the mouth with catgut sutures. Kocher does not suture the skin-wound; many surgeons do suture it and employ drainage-tubes. I follow the suggestions of



Fig. 510.—Kocher's excision of tongue (Esmarch and Kowalzig).

Treves as to after-treatment. Some hours after the operation, when oozing has ceased, dust the mouth-wound with iodoform. The patient, as soon as possible, is propped up in bed, and he must not swallow the discharges if can be avoided. The mouth, every half hour, is sprayed with peroxid of hydrogen and washed with a carbolic solution (1:60). Every three hours after washing the floor of the mouth and the stump the parts should be dried with absorbent cotton and dusted with iodoform. For twenty-four hours after the operation nothing is given by the mouth except a little cracked ice, the patient being fed per rectum. At the end of twenty-four or forty-eight hours some liquid food is given from a feeding-cup. The patient will soon learn to swallow; but if he cannot swallow easily, he is fed with a tube. Treves, in his clear and positive directions for after-treatment, states that nutrient enemata

are to be continued until sufficient nourishment is taken by the mouth; the mouth should be flushed by irrigation, and must be washed immediat after taking food; that morphin is to be avoided; and that the patient usually leave the hospital in from seven to ten days.

Whitehead's Operation.—Whitehead removes the entire tongue from with the mouth by the use of scissors. He passes a ligature through the tip, cuts to frenum, draws the tongue strongly forward, and separates by a series of clip with the scissors. The lingual arteries are tied as cut. "The stump should be kept under control, as regards hemorrhage, by a stout silk ligature passes through the remains of the glosso-epiglottidean fold and retained for twenty four hours."\*

Heath has shown that if the forefinger be passed to the epiglottis and used to "hook forward" the hyoid bone, the lingual arteries are stretched and portions of the tongue can be removed almost without bleeding. It is rarely desirable in Whitehead's operation to remove the glands and the tongue at one séance. To do so increases shock and the danger of death. The rule of procedure set forth by W. Watson Cheyne † is eminently wise. This rule is as follows: If glandular involvement is trivial or not detectable, it is perfectly proper to remove the tongue first, and after a week or so remove the glands. If the glandular involvement is marked, growth in the glands will be much more rapid than growth in the tongue. In such a case the glands should be removed before the tongue, because, if the tongue is removed before the triangles are cleared, in the week or two of waiting the case may become inoperable. In the majority of cases clear out the triangle before removing the tongue, doing the other operation in one or two weeks when the wound in the neck is healed. If the disease in the mouth is far advanced, do both operations at one séance.

Stricture of the Esophagus.—Fibrous or cicatricial stricture is due to the healing of an ulcer, and results from traumatism, chronic inflammation, syphilis, tuberculosis, chronic ulcer, prolonged vomiting, variola, gout, or to swallowing a corrosive substance or a boiling liquid. It is commonest in the young, and is apt to be situated opposite the cricoid cartilage, at the tracheal bifurcation or near the cardiac end. Cicatricial strictures are usually single, but may be multiple. Stricture following impaction of a foreign body is located at the seat of impaction unless the tube has been injured by efforts at extraction, in which case multiple strictures may exist (Maylard). Strictures which result from swallowing boiling fluid or corrosive liquid are usually very extensive, and may be multiple. Syphilitic stenosis is due to the healing of a gummatous ulceration, but there is nothing characteristic in this kind of stenosis. Tuberculous stenosis is extremely rare.

Symptoms of Cicatricial Stenosis.—The condition may occur at any age. The chief symptom is difficulty in swallowing, at first slight, but becoming more and more pronounced until swallowing is almost or quite impossible. The dysphagia is first manifested to dry solids, then to all solids, and finally to liquids. In some cases vomiting occurs after swallowing. If the stricture is high up, the vomiting is almost immediate; if it is low down, the vomiting is delayed, especially if the canal is dilated above the stricture. From time to time the patient vomits independently of taking food, the ejected matter being saliva. The vomited matter is not bloody. The patient feels weak and

<sup>\* &</sup>quot;American Text-book of Surgery."

hungry, becomes exhausted and emaciated, and suffers from flatulence, ga

tralgia, and constipation.

There is occasionally slight uneasiness or even pain in the region of the stricture, possibly "about the epigastrium or between the shoulder-blades (Maylard). The stricture may be located with a bougie and by auscultation over the spine on a line with the supposed obstruction. While a patie is swallowing water, the arrest of the fluid at the seat of stricture may audible. Even if the fluid passes, it will be delayed for a time and the dur tion of deglutition is thus prolonged. In order to determine the time deglutition put the ear just below the angle of the left scapula, put a fing on the patient's Adam's apple, and hold a watch in the other hand. Have the patient take a drink of water. Count the time from the moment the Adam's apple begins to rise until the fluid is heard to gurgle into the stomac (Ogston's method). It ordinarily requires four seconds for food to pa From the mouth into the stomach (Maylard). If food is retained for some tin before it is ejected we may be able to locate the seat of obstruction by the x-ray An emulsion of bismuth is swallowed and a skiagraph is taken. The bismut is seen on the plate as a black mass extending above the seat of constriction The bougie can be passed until it reaches the block and a skiagraph may be taken with the bougie in position.

In a case reported by Seelig ("Surgery, Gynecology, and Obstetrics Sept., 1908) the patient was directed to swallow a fine gold chain as thic as ordinary wrapping twine. The chain was about two feet long. If diverticulum exists the chain will fill the sac and a skiagraph will show the position of the diverticulum. If no diverticulum exists the plate will show the

chain nearly in the middle line of the body.

The history of the case is of much importance in diagnosis. The surged must inquire about impaction of a foreign body, or swallowing of acid alkalies, or boiling fluids; and must examine for evidence of syphilis. there is no history of injury, syphilis, tuberculosis, variola, or prolonged voming, and the patient is over forty years of age, the indications point to cancerather than cicatricial stenosis. The easy passage of a bougie when the patient is anesthetized shows that spasm is the cause, and not organic diseas Narrowing due to external pressure is marked by positive symptoms of the causative disease.\*

Treatment.—Thiosinamin is given by some physicians, but I have new seen it accomplish the slightest good. Telleky† recommends it in old sca without inflammation. He makes a 15 per cent. alcoholic solution and inject from one-half to one syringeful at a dose, throwing the fluid beneath the ski between the scapulæ. He uses twenty doses in the course of two week Gradual dilatation through the mouth is a method employed for at least time in almost every case. It is the method of choice when it can be carried out, and usually it can be carried out. Begin with the largest bougie whice will easily pass. Warm the bougie, oil it, pass it gently, and hold it in position for several minutes, prolonging the time of retention of the bougie as treatment progresses. Pass an instrument every second or third day, gradual

<sup>\*</sup> See the excellent article in Maylard's "Surgery of the Alimentary Canal." † Wien, klin, Woch., Feb. 20, 1902.

increasing the size. If the stenosis involves a considerable portion of the esophagus, gradual dilatation will almost certainly fail to cure.

Symonds advocates the insertion of a tube through the stricture and leaving it in place until there is decided dilatation, and then replacing the tube with a larger instrument. The patient is fed through the tube. Gradual dilatation from below has been practised in cases where a bougie could

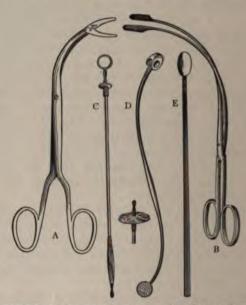


Fig. 511.—Esophageal instruments: A, B, Forceps; C, horsehair probang; D, coin-catcher; E, esophageal bougie.

not be passed from the mouth. A gastrostomy is performed, and after the fistula has become sound the patient is made to swallow "a shot to which is attached a silk thread" (Maylard). The silk thread is brought out through the fistulous orifice and is attached to a bougie, and the dilating instrument is pulled up through the esophagus. Forcible dilatation can be employed through the mouth or through a gastrotomy opening, by means of bougies, tents, or divulsing instruments. Electrolysis is used by Fort and others. Some surgeons perform internal esophagotomy through the mouth with a special instrument. A fibrous stenosis in the region of the cricoid cartilage which is not cured by gradual dilatation should be treated by the operation of external esophagotomy. In this operation the stricture is divided by a longitudinal incision; "funnel-shaped retraction of the cut portion is caused by adhesion to the external tissues divided, and it lessens future contraction."\* If dilatation fails in the case of a stenosis above the line of the aortic arch, the esophagus may be opened above the stricture (external esophagotomy), a tenotome is introduced through the wound, the stricture is cut and well dilated by the passage of instruments. This operation is known as Gussenbauer's combined esophagotomy.

<sup>\*</sup> W. J. Mayo, Jour. Amer. Med. Assoc., July 29, 1899.

If a stricture is impassable from above, the stomach should be opened and retrogade dilatation be carried out. Billroth showed years ago that a stricture impassable from above may be passable from below. This is because the esophagus above the stricture is basin shaped and immediately below the stricture is funnel shaped (Abbe). If a fine bougie is carried from the stomach to the mouth it is used to carry a piece of string through the same route, and

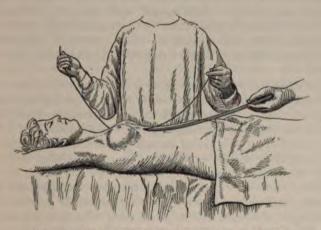


Fig. 512.—Abbe's method of cutting esophageal strictures.

This string is used to pull bougie after bougie through the stricture. A firm, by Abbe's method (Figs. 512 and 513). He performs a gastrotomy, sutures stomach to the abdominal wound to prevent contamination of the peritum, and seeks for the esophageal opening by two fingers passed within the stomach. Abbe points out that finding the orifice would seem much more than it is. In a recent case I found it only after a prolonged search, the



Fig. 513.—The bougie engaged in the stricture while the string-saw is being used.

entire esophageal region feeling smooth to the touch. Abbe says that "this surface is maintained by the circular sphincteric muscle layers, and it is not until a moment's pressure of the finger at the right place causes them to yield that it slips upward into the esophagus" ("Med. Record," Nov. 30, 1907). He then passes a long filiform whalebone bougie from the stomach into the mouth, ties a piece of braided silk to the bougie, withdraws the instru-

ment, and leaves the silk in place. One end of the silk emerges from the mouth and the other end from the gastrotomy wound. In some cases he opens the stomach and also opens the esophagus above the stricture; one end of the string comes out of the esophagotomy wound and the other end out of the gastrotomy wound. A large dilating bougie is then passed from the stomach into esophagus and pushed as forcibly as is safe into the lumen of the strict. The string is used as a string- or bow-saw, and the stricture is divided, the lating bougie being pushed firmly upward while the saw is being used. this is not done the saw will not cut. Only stretched tissue will be divided. When the stricture has been divided, the silk is withdrawn, full-sized bour are passed, a temporary gastrostomy is usually made, and the wound or would are sutured.

An operation devised by A. J. Ochsner is thus described by Mayo \*: "Tanterior wall of the stomach is drawn out of a left oblique incision through abdominal coverings; a small opening is made into the stomach sufficient in sto introduce the finger. A whalebone probe, to the tip of which a silk striguide has been tied, is now passed through the esophagus either from abour retrograde, as in the Abbe method. With this guide a loop of silk drawn out of the gastric incision in such manner as to leave the guide a third string. Into this loop a small soft-rubber drainage-tube three fewor more in length is caught in the middle by traction on the ends of the double thread through the mouth; this loop of rubber tube is drawn through the stomach and made to engage in the stricture.

"The greater the amount of traction, the smaller the stretched rubbe tube, until it is sufficiently reduced in size to enter the stenosed portions by alternating the direction of the pull the tube is drawn out by its free end and in by the silk loop. Increasing sizes of tubes can be employed, and if necessary the third string can be used as a string-saw, after the Abbe plan of procedure." In a very severe case of stenosis gastrostomy is performed to keep the patient from starving. In a case of fibrous stenosis in charge of the author it was found impossible to insert any instrument from above or from below. Gastrostomy was performed by Kader's method. The patient was fed through the artificial opening and the esophagus was thus put at rest. Twoweeks after the operation it became possible to pass a bougie from the mouth. The gullet was gradually dilated to its normal caliber and the gastrostomy wound was closed. This case demonstrates that a stricture of the esophagus, like a stricture of the urethra, may become temporarily impassable from inflammation, edema, and spasm; but, after the part is put at rest, will again permit the passage of an instrument.

Carcinoma of the Esophagus.—Cancer causes obstruction of the esophagus. It arises in those beyond middle life, and is far more common in men than in women. The disease may begin at any portion of the gullet, but is least often met with in the central portion (Maylard, Butlin). Epithelioma is the usual form, but scirrhus or encephaloid may occur. Cancer soon ulcerates, involves adjacent parts, and affects the deep cervical and posterior mediastinal glands.

Symptoms of Cancerous Stenosis.—The patient is over forty years of age, is usually a male, and presents the same difficulty of swallowing met with

<sup>\*</sup> Jour. Amer. Med. Assoc., July 29, 1899.

in cicatricial stenosis. The vomited matter is apt to contain blood; the use of the bougie causes bleeding; there are generally decided pain and very great emaciation. The seat of obstruction is located by the bougie and by listening over the spine while the patient is attempting to swallow water. The stomach is the seat of pain; the mouth is dry, and there is often great thirst. As the disease infiltrates, the involvement of adjacent regions produces other symptoms. Dyspnea may result from tracheal pressure. Pleuritis, pericarditis, or pneumonia may arise.

Treatment.—The disease is of necessity fatal, and treatment is only palliative. Complete excision is scarcely feasible. The patient should be put upon a soft, bland diet, small quantities being given frequently. When trouble is experienced in swallowing the bland and soft food, pass a soft bougie every third or fourth day. When the patient becomes entirely unable to swallow soft food, we may insert a Symonds tube or do an esophagostomy (if this can be performed below the stricture), or perform gastrostomy. In every doubtful case of esophageal stricture give a course of iodid of potassium before per-

forming any operation.

Spasmodic Stricture of the Esophagus (Esophagismus; Hysterical Stricture).—By this term is meant a spasm of the circular muscular fibers of the gullet, which is most common near the larynx or the cardia. This condition not unusually arises in a hysterical individual, in which case it will be associated with the stigmata of hysteria, especially globus hystericus. In some cases evidences of hysteria are wanting, although the patient is neurotic and ill-nourished, and the condition is due to a reflex irritation. A spasm of the muscular fibers of the esophagus may be clonic or may be tonic. A clonic spasm may arise during vomiting or from some reflex cause; It may affect one part of the tube for a time and then shift to another, or may develop only in one particular region. Globus is a spasm which moves upward. Tonic spasm is in one fixed place. Most reflex spasms are tonic and result from cancer of the liver, cancer of the stomach, tonsillitis, glossitis, Pharyngitis, or inflammation of the epiglottis (A. L. Benedict, in "Am. Jour. Med. Sciences," August, 1904). Spasmodic stricture may also arise during Pregnancy and as a result of laryngeal ulceration. I have seen two instances due to cancer of the stomach. In one of these cases the esophageal spasm entirely disappeared after the performance of pylorectomy. It occasionally occurs in tetanus, and sometimes in epilepsy.

Symptoms of Spasmodic Stenosis.—It arises suddenly in a hysterical or neurotic individual. It may last for a time and suddenly pass away, or may persist for a long time. The difficulty in swallowing is irregular, rarely interfering seriously with nourishment, and sometimes solids are taken more

readily than fluids, and vice versa.

There may be regurgitation; but if it occurs, it does so at once on swallowing food. Examination with a bougie detects the obstruction. If the bougie is held firmly against it, in most cases the spasm will, after a time, relax suddenly or gradually and let the instrument pass. A medium-sized instrument or a large instrument may not pass until the patient has been anesthetized, but in every case a bougie can be passed after an anesthetic has been given.

Treatment.—The systematic passage of bougies. Occasionally the passage of an instrument but once will cure a case. The general health must be

improved, and in persistent cases it may be necessary to use electricity within the esophagus, employ cold locally, and administer the bromids.

Diverticula of the Esophagus.—Maylard tells us that these pouches may be due to one of four causes—they may be congenital; may be due to stricture; may be caused by pressure from within, upon a weak spot of the wall; may be due to traction from without, by the healing and contraction of an area of inflammation. To these another cause should be added,

muscular weakness resulting in dilatation.

Symptoms.—When the diverticulum is in the neck, a lump forms during deglutition, and this lump may be obliterated by pressure. Food will pass into the stomach only when the diverticulum is full. A bougie cannot be passed unless the pouch is full of food, at which time it may pass or may not. Sometimes it enters the pouch. This latter symptom, the variability in the passage of the bougie, is the evidence relied on for diagnosis in introthoracic diverticula. By listening with a stethoscope fluid may be heard to pass into the pouch. After a patient swallows an emulsion of bismuth or food mixed with subnitrate of bismuth a diverticulum may be skiagraphed. When a bougie is passed as far as it will go a skiagraph should be taken with the bougie in position. The plate may show that the instrument is so much deviated to the side that it must be in a pouch. If a fine gold chain is swallowed it may fill up the pouch, and if it does, a skiagraph will indicate the diverticulum. The opening of the pouch may be seen by means of an esophagoscope.

Treatment.—Extirpation and suture, as performed by von Bergmann, Hearn, and others. For five days after operation no food is given by the mouth.

Injuries of the Esophagus from Within.—Injuries of the internal surface are more common than injuries from without. Burns and scalds are among these injuries. Wounds may be inflicted by foreign bodies. Injuries of the gullet cause pain on swallowing, and a severe injury induces bleeding, the blood being both coughed up and vomited. A severe wound may involve a large vessel and cause violent or even fatal hemorrhage. If the brenchus or trachea is involved, there will be "cough and expectoration of blood, mucus, and food" (Maylard). The pleural or pericardiac sacs may be perforated.

Treatment.—Feed only by the rectum. Give morphin hypodermatically. Do not feed by the mouth for ten days, and even then give only fluid food and jelly. Symptoms are met as they arise. After burns by caustic, administer the antidote; give large drafts of water and wash out the stomach. From two to four weeks after a caustic has been swallowed and after a burn or scald the use of sounds should be begun, and sounding should be persisted in for a considerable time to prevent contraction.

Injuries of the Esophagus from Without, Other Structures not being Seriously Involved.—Such injuries are rare. Esophageal injuries, as a rule, are associated with serious damage to adjacent structures. These injuries may be due to stabs or to bullets. Besides the obvious external signs of the injury there will be difficulty in swallowing, cough, bloody expectoration, or vomiting; and mucus or the contents of the stomach may run out of the wound.

Treatment.—Suture the wound, and feed by the rectum for ten days.

Foreign Bodies Lodged in the Esophagus.—These accidents occur especially in children and lunatics, and women are more apt to suffer from them than men. A list of various bodies which have been swallowed will be found in Poulet's elaborate treatise. There are three regions where a foreign body is especially apt to lodge—viz., opposite the cricoid cartilage,



Fig. 514.—Author's case of whistle in esophagus removed by external esophagotomy.

at the level of the diaphragm, and at the point where the left bronchus crosses the gullet. Small and sharp bodies may lodge anywhere.

Symptoms.—The symptoms are variable; if the body is large, there will be pain and difficulty in swallowing, and, in some cases, dyspnea from pressure upon the trachea or bronchus. Occasionally the dyspnea is such a prominent feature that it misleads the physician into the belief that the foreign body is lodged in the air-passages. Death may actually result from asphyxia. In



Fig. 515.—Author's case of jackstone in esophagus removed by external esophagotomy.

some other cases the symptoms are very slight. If the body is sharp, there will be hemorrhage and severe pain. The blood may be hawked up, or may be swallowed and vomited. A patient may grow accustomed to a foreign body and cease to notice it; but, on the contrary, the foreign body may produce inflammation, and may even ulcerate into the windpipe, the pleura,

the pericardium, or the aorta. In many cases of impaction a patient makes violent efforts to hawk and produces aphonia. There may be violent retching. Even after a foreign body has been removed by swallowing or otherwise a sensation is apt to remain as if it were still lodged. The diagnosis is made by the history, the detection of the body by external manipulation, by feeling it with an esophageal bougie, and, if bone or metal, seeing it with

the fluoroscope or obtaining a skiagraph.

Treatment.—The surgeon should learn, if possible, the size, shape, weight, and nature of the foreign body, and should locate its point of impaction. The exact point of lodgment of bone or a metallic body is determined by the x-rays.\* An anesthetic is given before manipulating in a child, a nervous woman, or a lunatic, and is sometimes necessary for a man. If the foreign body is soft, external manipulation may succeed in altering its shape, so that it may be swallowed or ejected. If the foreign body is hard, external manipulation may shift its position. It is usually impossible to reach the foreign body through the mouth by means of the fingers (when the body is in the rear of the pharynx it may be pulled forward or pushed down). Sharp foreign bodies may be entangled and carried down when the patient eats mush, bread, or boiled potatoes. The administration of emetics is an old plan which occasionally succeeds, but which is too unsafe to be employed. Maylard says that when a mass of food is impacted it is occasionally possible to soften and disintegrate the mass by administering a mixture containing pepsin. The horsehair probang is a very useful instrument (Fig. 511, c). It may be used to push a body downward into the stomach, or to catch the body and pull it up. When this instrument is withdrawn, it opens like an umbrella. Maurice H. Richardson has shown that in an adult the diaphragmatic opening is about fourteen and one-half inches from the incisor teeth, a point to be remembered in deciding whether to push down or pull up the impacted article. Esophageal forceps (Fig. 511, A. B) are valuable in some cases. The coin-catcher (Fig. 511, D) is a useful instrument. Créquy's plan of removal is to take a tangled mass of threads, tie a stout piece of string about the middle of it, coat it with sugar, and have the patient swallow it. It may pass the foreign body; if it does so, on withdrawal it may entangle the object and extract it. To remove a fish-hook with line attached, the following plan may prove successful; stick the line which projects from the mouth into a metal catheter, carry the catheter down to the hook, and push the hook out. It is not proper to allow a foreign body to remain in the esophagus until it causes ulceration. Neither is it proper to make prolonged efforts to extract it through the mouth. Such efforts may do great barm, and if one careful and consistent effort fails, an operation should be performed. If the body is lodged anywhere above the lower third of the esophagus, external esophagotomy is performed, and usually on the left side. Through this wound the foreign body is extracted. The cut is made on the left side, between the trachea and larynx in front and the carotid sheath behind, the center of the incision being opposite the cricoid cartilage. After the foreign body is extracted the mucous membrane is sutured with chromicized catgut, and the superficial structures are closed with silkworm-gut after a drainage-tube has been inserted. The patient is fed by the rectum for eight or

<sup>\*</sup> See cases of White, Keen, Alfred Wood, MacIntyre, Taylor, and others.

ten days. When a foreign body is lodged in the lower portion of the tube, the stomach is opened and the body extracted by this route (Richardson). In White's case of jackstone in the gullet gastrotomy was performed. A string was tied about some rolls of gauze, the string was passed by means of a whalebone from the stomach into the mouth, and the body was entangled and drawn out.

Surgical Invasion of the Mediastinum.—The posterior mediastinum has been entered in order to remove a foreign body from the bronchus and to extract a set of false teeth wedged in the esophagus. The same method can be followed to reach suppurative processes in the mediastinum, abscesses of the lung otherwise inaccessible, and diverticula and carcinomata of the lower end of the gullet. Nassilov resects ribs close to the spine. The portion of the esophagus above the aortic arch can be reached after partial resection of the third, fourth, fifth, and sixth ribs of the left side. The inferior portion of the esophagus can be reached after resecting portions of the lower third or fourth ribs on the right side (Binnie's "Operative Surgery"). The anterior mediastinum may be entered to remove a bullet, to drain an abscess, to reach a wound of the heart or lung, and to explore for the cause of symptoms. I explored the anterior mediastinum after rib resection, found a bullet imbedded in the aorta, and allowed it to remain. The patient recovered. M. H. Milton\* splits the sternum and separates the two pieces.

Invasion of the mediastinum is much safer if the operation is performed in the Sauerbruch chamber or with the aid of positive pressure within the bronchi. Either of these plans will prevent pulmonary collapse if the pleura is opened.

<sup>\*</sup> Lancet, March 27, 1897.

## XXVII. DISEASES AND INJURIES OF THE ABDOMEN.

Diagnosis of Intra-abdominal Emergencies.-The exact diagnosis is always difficult and is not unusually impossible. What a surgeon must try to determine, and what he usually can determine, is whether he is dealing with a trivial and temporary derangement for the relief of which an operation is entirely unnecessary, or whether he is confronted with a grave calamity which imperatively demands immediate surgical aid. We can decide that a calamity exists, but the exact nature of the lesion is often doubtful until operation is performed. Every operation in such a case is exploratory. Before the diagnosis of a calamity is made morphin should not be given, because it allays the pain, relieves the anxiety, causes the disappearance of rigidity, lowers the pulse, abates shock, and hence veils the real situation, so that the most discerning surgeon will probably be misled. If shock is profound, diagnosis is usually impossible, unless shock is due to hemorrhage, and immediate operation during shock is not to be thought of except to arrest bleeding. If excessive and continued hemorrhage is suspected, immediate operation is indicated. If it is not suspected, the patient should be covered with blankets and surrounded with hot-water bags, atropin should be given hypodermatically, and hot salt solution should be administered by rectum, subcutaneously, or intravenously. Suprarenal extract is a valuable remedy to maintain blood-pressure in shock (Crile). When the patient reacts, and he usually will react, an attempt is made to make a diagnosis. It is perfectly proper to give a single hypodermatic injection of morphin (gr. 1) after the effort has been made to diagnosticate the condition. The danger of deluding the surgeon is past and the drug abates pain, lessens peristalsis, relieves mental anxiety, and is distinctly beneficial. Before the morphin was given the surgeon came to a conclusion as to the necessity for operation. After the morphin has been given, if an operation is indicated, it is performed as promptly as circumstances admit. Whenever it is esteemed consistent with safety, the patient ought to be removed to a hospital for operation,

Contusion of the Abdominal Wall without Injury of Viscera.—
In some cases of contusion of the abdominal wall only the parietes are damaged; in other cases the viscera or the abdominal tissues are injured. Contusion may involve the skin alone, or may involve the skin, muscles, and peritoneum. In simple contusion there is considerable shock if the injury is severe. There is pain, increased by respiration, motion, pressure, and attempts at urination or defecation. When tenderness appears some days after the accident there is usually deep-seated injury. Extensive ecchymosis may appear. Even after a severe contusing force has been applied there may be no discoloration, and it may happen that after a slight force there is much discoloration. There is great ecchymosis in anemic persons, victims of hemiplegia, in obese individuals, opium-eaters, and drunkards. In severe cases the tissues are pulpified and sloughing inevitably ensues. Abscess occasionally follows contusion. The prognosis after abdominal contusion is

always uncertain.

Treatment of Simple Contusion.—In treating simple contusion place the patient at rest in a supine position, with the thighs flexed over a pillow; obtain reaction from the shock. Give morphin if pain is severe. After shock has passed off it is advisable to place an ice-bag over the seat of injury. If much blood is extravasated into the abdominal wall, aspirate and apply a binder. After twenty-four hours apply local heat by means of the hotwater bag, employ an ointment of ichthyol, and move the bowels, if necessary, by salines. Regard every contusion as serious, and watch carefully for the development of signs of internal hemorrhage or visceral injury.

Muscular Rupture from Contusion.—In this injury there are severe hock and pain (increased by respiration and movement). Separation between the fibers of the muscle is distinct at first, but it is soon masked by flusion of blood. Such injuries may cause death, or may lead to hernia. The rectus is the muscle most apt to rupture. The rupture is due to sudden ontraction rather than to the direct effect of a blow.

The treatment is the same as for simple contusion. Always apply a inder. A hernia is returned and a compress is applied over the opening the rough which it emerged. If strangulation occurs, operate at once.

Injuries with Damage to the Peritoneum or the Viscera.—

upture of the Peritoneum.—The peritoneum may be involved in an dominal contusion. It may rupture even when there is no visceral injury muscular contusion. The uterine peritoneum, the parietal peritoneum, visceral peritoneum, or the mesentery may rupture. Rupture of the peritoneum causes intra-abdominal hemorrhage.

The treatment consists in opening the abdomen, arresting the hemorrhage, and bringing about reaction.

An injury to the peritoneum creates a point of least resistance, and at such a point peritonitis may develop. The peritonitis is usually local, but may become general. After any severe intra-abdominal injury the symptoms of peritoneal shock appear (peritonism), and the patient may rapidly die. In the condition of peritonism the temperature is subnormal; the extremities are cold; the face is pallid and sunken; the pulse is small, weak, and very frequent; the respiration is shallow and sighing; there is great thirst; the patient is restless and turns uneasily, and there is rigidity and distention. Vomiting almost always occurs. In some cases there is regurgitation rather than vomiting. The abdomen is the seat of a violent, persistent pain. The patient is fearful of impending death. As the symptoms develop in a grave case they will point to one of two conditions—hemorrhage or peritonitis.

In intra-abdominal hemorrhage the subnormal temperature and other evidences of shock persist. Vomiting ceases, but nausea exists. The patient is uncontrollably restless and tosses about in bed. The thirst is great. The abdomen is rarely rigid. Fainting-spells occur. Blood-examination shows a marked fall in the percentage of hemoglobin. Percussion demonstrates the existence of an effusion which alters its position as the patient's position is altered, and which gradually increases in amount. Dulness is first met with in the loins. Digital examination of the rectum or vagina may aid in diagnosis because in hemorrhage blood gathers in the rectovesical pouch. If peritonitis develops, the vomiting becomes worse, the pain intensifies, and the abdomen grows rigid and distended.

sible that some of the cases were not positively instances of rupture. Nevertheless, the lesion, for reasons previously stated, is not nearly so dangerous as rupture of the intestine. Another reason for the greater danger of intestinal rupture is that fecal matter is much more poisonous than the gastric contents. Laparotomy has lessened the mortality of rupture of the stomach. Petry and also Eisendrath mass together operations for rupture of the stomach and rupture of the intestine. Petry finds the group mortality to be 52.3 per cent., and Eisendrath finds it to be 52.5 per cent. Statistics referring to the stomach alone should show a lower death-rate.

Rupture of the Intestine without External Wound.—In a great majority of cases the damage is produced by direct violence. In some few cases the force is indirect (falls on the feet or buttocks, blows on the back or loin). The injury may result from oscillation or from compression (the younger Senn). The common cause is undoubtedly compression of the gut against the pelvis or vertebral column, but it is certain that a gut containing fluid may be ruptured purely by violent shaking or oscillation. If oscillation produces the damage, the rupture is on the portion of gut furthest from the mesentery; if compression is the cause, any part of the bowel may suffer. Rupture is most apt to occur if the belly is relaxed. It is predisposed to by adhesions, disease of the wall of the bowel, and irreducible hemia (the younger Senn). Most ruptures are complete. In a very few ses the tear extends only through one or two of the coats and the rupture incomplete. A contusion of the gut may be followed by rupture several days after the injury. A complete rupture usually permits leaking of feces, but in very rare cases a small opening is plugged up by pouting mucous membrane. Leaking may be delayed from a rupture because intra-abdominal Pressure may for a time keep the opening pressed against a section of sound But (the younger Senn). The amount of damage to the belly wall does not Convey any notion of the amount of visceral injury. The belly wall may be severely injured and the viscera escape. With only a slight contusion of the wall there may be extensive visceral injury. Homer Gage \* collected 85 cases; in 75 the injury was due to direct force, and in 32 of these the force was inflicted by the kick of a horse or of a man. In one of my cases it was due to the kick of a horse, in one to the kick of a man, and in one to a crush inflicted by a cart-wheel. The victims in the majority of reported cases were young men, probably because young men are most apt to be exposed to violence. In 78 collected cases (Gage) the situation of the injury was specified: The duodenum, 10; jejunum, 20; ileum, 42; large intestine, 6. Curtis found the large intestine injured in 4 cases out of 113, and Poland, in 5 cases out of 64. In many cases there is more than one tear, and sometimes many tears exist. Both the large and small intestines may suffer. Chavasse collected 106 cases in which the ileum or jejunum suffered, 19 in which the large intestine did, 7 in which the duodenum did, 7 in which both the large and small intestine were involved, and I case in which the rectum was ruptured (quoted by the younger Senn in "Am. Jour. Med. Sciences," June, 1904). As Makins points out, the portion of gut most apt to be injured is a portion hanging low in the pelvis, because a loop in this situation is most easily squeezed against bone by a blow on the belly. The mesentery may be lacerated (in 7 per

<sup>\*</sup> Annals of Surgery, March, 1902.

cent. of cases, according to Gage; in 16 per cent., according to Curtis). The symptoms of rupture of the intestine are profound shock, tympanites, abdominal pain, and rigidity, rapidly followed by peritonitis if the patient survives. In some cases pain is referred to the back. Vomiting comes on soon after the accident, the vomited matters being possibly at first bloody and later stercoraceous. The respiration is thoracic, the tongue is dry, and great thirst exists. The pulse, which is slow at first, becomes small and rapid and of high tension. Blood in the stools rarely appears early enough to be of diagnostic value, and there may be diarrhea or constipation. The respiration is costal. Dyspnea exists. There may be no marked symptoms for an hour or two or for many hours. Cases are on record of people with ruptured intestine returning to work perhaps for hours. Holland's patient had no symptoms for twenty-four hours, although the jejunum was ruptured. Poland's patient ruptured the duodenum but walked one mile. The escape of gas into the peritoneal cavity may cause the diminution or disappearance of liver-dulness. After anesthetizing the patient, hydrogen gas insufflated into the rectum will come from the mouth if there is no perforation in the stomach or the intestine; if a perforation exists, tympanites is much increased, and the area of liver-dulness may disappear. To apply rectal insufflation of hydrogen, generate the gas in a bottle by means of zinc and sulphuric acid, catch the gas in a large rubber bag, and attach the tube from the gas reservoir to a tip which is inserted in the rectum. Give the patient ether to relax the abdominal muscles, direct an assistant to press the anal margins against the rectal tip, and when the patient is unconscious, turn on the stopcock and press upon the reservoir (the elder Senn).

It has been suggested that ether vapor, mixed with air, can be used instead of hydrogen gas.\* In this method a little ether is poured into the bottle of an aspirator, the valves are opened, one tube is carried into the rectum, the other tube is attached to a bicycle pump, and by working the pump the ether vapor is driven into the bowel. If there is perforation, tympanites is notably increased. Most surgeons regard the rectal insufflation test as unsatisfactory and often dangerous. Personally I am not inclined to use it. Its application requires considerable time, it must of necessity increase fecal extravasation, and, as Le Conte† says, it "so distends the intestines that it may be impossible to return them to the abdominal cavity until they have

been emptied of gas."

Treatment of Rupture of Intestine.—If symptoms point to dangerous hemorrhage, and in any case in which the patient does not seem to be reacting, but is rather getting worse, operate at once. If in doubt as to whether or not rupture exists, make every endeavor to bring about reaction, and explore. Reaction is brought about as previously directed. Asepticize and anesthetize. Perform a laparotomy, making the incision in the middle line and below the umbilicus; note if gas escapes when the peritoneum is opened or if fecal material or an inflammatory exudate flows out; check hemorrhage; start at a fixed point and conduct a careful search to find the rent. When the rent is found, it should be closed by Halsted sutures if possible. It is only a small rupture, however, which can be so treated. Most large tears

<sup>\*</sup> Emerson M. Sutton, of Geneva, in Jour. Am. Med. Assoc., July 23, 1898. † Am. Jour. Med. Sciences, Dec., 1901.

make resection necessary. Because of the frequency of multiple lesions the surgeon must not be sure he has finished his work when he finds and closes one tear, but he must determine by careful search that no other tears exist. The surgeon notes if there is injury of the mesentery and if the circulation of any portion of the bowel is interfered with. If there is serious impairment of circulation in any part of the bowel-wall, perform intestinal resection, followed by end-to-end approximation or lateral anastomosis. In some cases of rupture the patient is so severely shocked that it is impossible to do a resection with any hope of the patient living. In such a case stitch the ruptured portion of gut to the belly-wall. The opening in the gut becomes a fecal fistula, and if the patient survives, can be subsequently closed (Senn). The same procedure is proper if the bowel is distended and paralyzed. After closing the opening in the bowel or resecting flush the abdominal cavity with hot saline solution, and wipe the peritoneal fossæ and the space between the liver and diaphragm with gauze. Finney eviscerates, wipes out the a bdominal cavity, and wipes the intestines as he restores them. This is justifiable if the operation is done soon after the rupture, but not in later cases, in which lymph has gathered on the bowel. Whatever method is used to cleanse the abdomen, remember that infectious material is apt to accumu-Late between the liver and diaphragm and in Douglas's pouch. Drainage is to be used. Suprapubic drainage is most advantageous. Place the patient sermierect and employ continuous proctoclysis of normal salt solution as directed for peritonitis. The value of operation for intestinal rupture is conclusively demonstrated. Curtis collected 116 cases which occurred before 1887. Not a case was operated upon, and every patient died. Homer Gage collected 85 cases since 1887: 45 were not operated upon and every one died; 40 were operated upon and 17 recovered. Eisendrath collected 40 cases operated upon. Nineteen recovered and 21 died (52.5 per cent.). The mortality of cases not operated upon is, according to Eisendrath, at least 93 per cent. The sooner after the injury operation is performed the greater the chance for success. The younger Senn points out that in operations done within four hours the mortality is 15.2 per cent.; in those done between five and eight hours it is 44.4 per cent.; in those done between nine and twelve hours it is 63,6 per cent., and in those done later it is 70 per cent.

Identification of the Small Intestine and of the Large Intestine.—
"In abdominal operations it is frequently imperatively necessary that the large intestine be recognized with certainty or the small bowel be positively identified. The size of the tube will not always aid in this recognition, as a small intestine may be distended enormously and a large intestine may be contracted to the size of a finger because of obstruction above. The longitudinal muscular fibers of the large bowel are accentuated in three portions; these accentuations constitute the three longitudinal bands which begin at the cecum and terminate at the end of the sigmoid flexure of the colon. Each band is composed of a number of shorter bands, the shortness of these constituent bands permitting the sacculation of the large intestine. Longitudinal bands and sacculation are not met with in the small gut, their presence or absence being a means of identification in many cases; but when the colon is much distended, the bands cannot be seen distinctly and the sacculation disappears. From the large intestine only spring the appendices

through a smaller incision, and that will diminish handling of it structures, tends to increase the chances of recovery. For thes writer suggests a method of bowel-identification which rests u that each bowel has a posterior attachment, that the origin of ment differs according to the bowel it supports, that a single fing the origin of the peritoneal support of any section of the bow origin being known, the portion of the bowel it supports is v deducible. In an exploratory operation, for instance, the fin contact with the bowel: to determine whether it is a large or a sma first if the structure is movable or is firmly fixed; next, pass the bowel and let it find its way posteriorly. If dealing with a the finger will reach the origin of the mesentery between the the second lumbar vertebra and the right sacro-iliac joint; if the large bowel, the finger will reach the origin of the meson point where the colon is fixed posteriorly and to the side."\*

Location of a Loop of Small Intestine (Figs. 516, 517, 511 Monks points out a plan by which, in most instances, we can learn imate accuracy what portion of the small intestine we may have l nals of Surg.," Oct., 1903). He learns first by observation of the vessels. Opposite the upper portion of the bowel there are prin loops only with perhaps an occasional small secondary loop. "secondary loops become more numerous, larger, and approach bowel than the primary loops in the upper part," and about th these secondary loops first become a "prominent feature." As primary loops become smaller, secondary loops become more no nearer the bowel, and possibly tertiary loops appear. Opposite t tion of the ileum the loops are not definite in arrangement, but network. Monks points out that opposite the upper bowel th when put gently on the stretch, "are straight, large, and regula give off branches to the mesentery," and are about 5 cm. long. one-third they are usually less than 1 cm, long, are smaller, are straight, are not so regular, and give off numerous mesente Monks further shows that fat impairs the translucency of the me



Fig. 516,—A loop of intestine, the middle of which is exactly three feet from the end of the codenum. The gut is of large size. The mesenteric loops are primary, and the vasa recta large, long, and regular in distribution. The translucent spaces (lunettes) between the vessels are extensive. Below, the mesentery is streaked with fat. The veins, which had a distribution similar to the arteries, are for simplicity omitted from this and from the subsequent drawings. The subject from which the specimen was taken was a male of forty years, with rather less than the usual amount of fat. The entire length of the intestine was twenty-three feet (Monks).

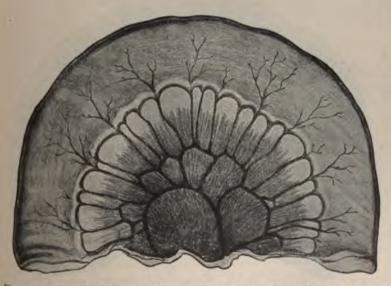


Fig. 517.—A loop of intestine at six feet. As compared with Fig. 516 the gut is somewhat smaller. The vascularity of the intestine and mesentery is less. Secondary loops are a prominent feature. The vasa recta are smaller. The lunettes are also present, but are not so large as in Fig. 516. The subject was a male of about thirty-five years, with an average amount of fat. The entire length of the intestine was twenty feet (Monks).

intestine is pulled downward we can determine if "the line of resistance from above is from the median line of the body or from the left or right of it."



Fig. 518.—A loop of intestine at twelve feet. The vessels are smaller. The primary loops are lost in the fat, but secondary and even tertiary loops are visible. The vasa recta are shorter, more irregular, and branching. The specimen came from the same subject which furnished Figs. 516 and 517 (Monks).



Fig. 519. —A loop of intestine at twenty feet. The gut appears to be thick and large. The mesentery is quite fat and opaque, and large and numerous fat tabs are present. The vessels, which are complicated, are seen with difficulty, and are represented by mere grooves in the lat. The subject was a stout woman, and the entire length of the gut was twenty-one feet (Monks).

This resistance of the mesentery indicates to which point the loop is attached, and hence what portion of bowel the loop comprises. I have used these observations of Monks repeatedly to great advantage.

Rupture of the Liver (page 1014).

Rupture of the Gall-bladder and the Bile-ducts (page 1014).—Rupture of the gall-bladder or the ducts is most apt to happen from injury when gall-stones exist. Peritonitis, general or local, is almost certain to follow such a rupture. Besides those symptoms common to all severe abdominal injuries, there is often intense jaundice.

Treatment.-Suture the laceration or make a biliary fistula.

Rupture of the Spleen (page 1046).

Rupture of Mesenteric Arteries .- The symptoms are those of hemorrhage. The superior mesenteric artery, the inferior mesenteric artery, or branches of either or both may be damaged. If branches of the superior mesen teric artery are divided near the bowel, gangrene of the bowel will result, but wound of a branch far from the intestine does not cause gangrene. The last branches are terminal arteries, hence the gangrene. The branches of the artery divide and form arcades arranged concentrically and the terminal arteries come from the peripheral arcades. In wounds of the vessels far removed from the gut anastomosis prevents gangrene (Labastie, in "Archives Générales de Chirurgie," Jan. 25, 1908). In most cases in which there has been rupture of mesenteric arteries, death from hemorrhage rapidly occurs. If the victim should not die of hemorrhage he is in danger of gangrene and peritonitis. Aldrich\* reported a case in which death occurred on the seventh day. The treatment is immediate laparotomy. If the wound is found close to the gut the portion of gut supplied by the cut vessel should be resected. If well removed from the gut simply ligate the vessel (Labastie, Ibid.). In a wound near the root of the mesentery perform extensive resection of the gut and remove also a portion of the mesentery.

Rupture of the Kidney (page 1278). Rupture of the Ureter (page 1280).

Wounds of the Abdominal Wall.—Non-penetrating wounds are to be treated on general principles. They are sutured with great care and are firmly supported externally. Ventral hernia may follow a large wound.

Penetrating Wounds.—The symptoms of penetrating wounds of the abdominal wall are usually those of shock and hemorrhage, and later of septic peritonitis. Emphysema is apt to occur and viscera may protrude, and often do in the case of a large incised or lacerated wound. Extravasation of contents of intra-abdominal viscera is very apt to occur, and is sure to occur if the viscus was distended when injured. Normal urine and normal bile may do little harm, but if either excretion is septic, disastrous consequences are certain to ensue. If intestinal contents escape, septic peritonitis is certain to occur. Bleeding is usually profuse and prolonged, because spontaneous arrest of hemorrhage from any vessel of considerable size will rarely take place within the abdomen.

Treatment.—The surgeon endeavors to discover promptly if a wound of the abdominal wall is or is not penetrating in character. This fact may be proved by protrusion of viscera, by the appearance of stomach-contents in the wound, or by a flow of bile, urine, or feces from the wound. If none of the above indications exists, and if there are no signs of serious hemorrhage, the wound should be irrigated with hot salt solution, and should be dressed with gauze, and every effort should be made to bring about reaction; otherwise operation should be immediate.

When reaction is obtained, the wound should be enlarged layer by layer until it becomes obvious whether or not the peritoneum is open. Madelung, of Strassburg, points out that incision layer by layer will be of no use in settling the question of penetration if the wound is in the chest, the buttock, the perineum, or the back of a fat individual.\* If after incision layer by layer it becomes evident that penetration has not occurred, the wound should be closed and treated on general principles. If it becomes evident that it has occurred, the abdomen should be opened at the point of penetration, and a thorough exploration of intra-abdominal structures should be made in order to determine injury and be able to treat it properly.

In a case still doubtful after incision by layers, do an exploratory laparotomy in the middle line. It is impossible to affirm from the appearance of the wound and from the symptoms that visceral injury has not occurred; hence in every penetrating wound in civil practice perform exploratory laparotomy.

In every case in which it is evident that penetration has occurred, laparotomy is necessary in order to detect and correct intra-abdominal injury, and to clean the peritoneum by flushing with hot salt solution. If viscera protrude, they must be washed off with hot salt solution and covered with hot sterile pads, and after the patient has reacted, the wound should be enlarged, the condition of the contents of the abdomen investigated, hemorrhage arrested, wounds properly treated, and the viscera returned.

It is customary to flush the belly with hot salt solution, some of the fluid being allowed to remain. This proceeding mechanically cleanses the peritoneum, removes blood-clots, and strongly combats shock. It is not absolutely necessary to flush out the belly unless a considerable hemorrhage has occurred or feces or stomach-contents have been extravasated. If extravasation of stomach-contents or feces has occurred, not only should flushing be practised, but evisceration should be carried out; the fouled intestine should be wiped off with gauze pads wet with hot salt solution, and be wrapped in hot moist towels; the peritoneal fossæ should be rubbed with gauze pads and the space between the liver and diaphragm should be carefully wiped.

A wound of the stomach should be sutured; a wound of the bowel may be sutured, or resection and anastomosis or resection and end-to-end suturing may be required. Visceral injuries are treated by appropriate means. In a punctured wound or a gunshot-wound of the intestine rectal insufflation of hydrogen gas when the abdomen is open may disclose the situation of the injury, but evisceration is usually practised instead.

After the completion of intra-abdominal manipulations the surgeon restores any protruding bowel.

Drainage is required when the contents of the stomach or the intestines have escaped, when hemorrhage is severe, or when the liver, pancreas, kidney, or spleen is found to be damaged. The peritoneum may be sutured with a con-

<sup>\*</sup> Annals of Surgery, Sept., 1807.

tinuous suture of catgut, and the muscles, fascia, and skin with interrupted sutures of silkworm-gut, or through-and-through sutures of silkworm-gut may be used. Active stimulation and artificial heat are needed immediately after the operation to combat shock. In many cases intravenous infusion of hot normal salt solution is of great value. It may be given both during and after operation. Enteroclysis, or high rectal injection of hot saline fluid, is useful. So is hypodermoclysis, or the subcutaneous injection of hot salt solution. The after-treatment consists of the semierect position, continuous proctoclysis of salt solution, avoidance of food by the stomach for forty-eight hours, and the administration of brandy and water from time to time. For two days the patient should be fed by the rectum. On the appearance of the first sign of peritonitis, forty-eight hours or more after the operation, give a saline cathartic. It is not wise to purge during the first forty-eight hours after the operation, unless a Murphy button was used. When there is no sign of peritonitis, a purge should not be given until the fourth day. After forty-eight hours liquid food can usually be given by the stomach. Solid food may be given after seven or eight days, but the patient must not leave his bed until the wound is firmly united, because of the danger of ventral hernia. A support should be worn for a long time. E. D. Fenner\* reports 39 stab wounds of the abdomen operated upon in the Charity Hospital of New Orleans. There were o deaths (23.07 per cent.).

Gunshot-wounds of the Abdomen.—The bullet may penetrate from the front, the side, the back, the chest, or the perineum. If a bullet has penetrated, it may or it may not have produced visceral damage. A pistol-bullet or the bullet of a sporting-rifle usually does; a projectile of a modern military rifle may not or may produce wounds which can be recovered from without operation. A urinary examination should be made promptly to see if blood is present.

In gunshot-wounds of the belly shock is usually due to hemorrhage, and in civil practice certainly prompt operation is indicated. The incision is made through the belly even when the shot entered the back. In some cases the opening is made through the wound; in others it is not; but in every case the wound is explored and cleaned. The incision should be long enough to permit of thorough work. After opening the abdomen our first duty is to arrest hemorrhage, our next is to look for perforations of the viscera and mesentery and close them. If the anterior wall of the stomach is perforated, close the opening and examine the posterior wall through an opening made in the gastrocolic omentum. If a posterior perforation is found, close it and insert posterior drainage into the lesser peritoneal cavity. As a rule, an intestinal perforation can be closed, but occasionally a portion of the intestine requires resection. If the bullet is encountered it is removed, but a prolonged search for it should never be made. Finally the abdominal cavity is cleansed, drainage is provided for, and the abdominal wound is closed. In one of my fatal cases the bullet entered the rectum low down and was not found. In a case of mine with 6 perforations of the small intestine recovery followed operation.

E. D. Fenner† reports 113 gunshot-wounds of the abdomen operated upon in the Charity Hospital of New Orleans; there were 78 deaths (69 per cent.). In a series of 14 cases operated upon by Vaughan the mortality was 64 per cent. ("Am. Jour. Med. Sciences," Feb., 1906).

Military surgeons have shown that wounds inflicted by the modern hard-

<sup>\*</sup> Annals of Surgery, January, 1902.

jacketed projectile are not so apt to involve fatal hemorrhage and disastrous complications; in fact, such wounds are often recovered from without operation, and sometimes with an entire absence of serious symptoms. Again, it is difficult or impossible to treat such cases as in civil practice, even were it desirable. In fact, in military practice the results are slightly better from expectant treatment, whereas in civil practice the reverse is true. Still, even in war, if conditions permit, operation should be performed if there is hemorrhage or obvious visceral injury, or if septic peritonitis develops. Treves says that in the Boer War only 40 per cent. of cases of gunshot-wounds of the abdomen not operated upon died, but, as pointed out by Hildebrandt, many cases die on the battle-field and while being taken to the hospital, hence the mortality is much higher. In the war between China and Japan the mortality from gunshot-wounds of the abdomen is said to have been about 77 per cent.

Gunshot-wounds of the Pregnant Uterus.—It is rarely that both walls are perforated, as the force of the bullet is greatly lessened by the uterine contents. As a rule, there are severe shock and hemorrhage, and occasionally amniotic fluid flows from the wound of entrance. The intestine may also be injured. As a rule, labor pains come on soon after the injury. Gellhorn\* has collected 18 cases. In this series there were 12 recoveries. The proper treatment early in pregnancy, if the wound is small, consists in emptying the uterus and closing the wound. A large wound, or any wound late in pregnancy, demands the Porro operation—removal of the uterus, ovaries, and tubes.

Omental Cysts.—Cysts may spring from the outer surface of the omen-

tum (escaped ovarian cysts, lymphatic cysts, dermoids).

True omental cysts arise within the cavity of the great omentum. There are 20 cases on record (Edwin M. Hasbrouck, in "Annals of Surgery," August, 1908). In 50 per cent. of cases the patient is an adult, but half of the reported cases were under ten years old. (Some of these were of congenital origin.) Hasbronck (Ibid.) points out that the condition is much more common in females than in males, that there are no characteristic symptoms, that the condition begins as omental endothelioma between the two surfaces of omentum which fuse because of inflammation and form a closed sac, that hemorrhages are apt to occur into the cyst, and that operation shows a mortality of 6 percent. The operation performed is extirpation.

Mesenteric Cysts.—These rare cysts are divided into (1) embryon (2) hydatid, (3) cystic malignant disease (Dowd, "Annals of Surgery," 1000 A great majority of mesenteric cysts are embryonic. Moynihan believes to embryonic cysts arise from "rests" from "the Müllerian or Wolffian organducts, or from the ovary," which are included between the folds of mesentem These rests undergo cystic degeneration. Mesenteric cysts grow and pass albetween the layers of mesentery until they reach the gut and then compared

the gut and push its wall ahead of them.

Such a cyst may contain embryonal material, bloody fluid, serous fluid, or lymph. In Harry C. Deaver's report of a case ("Annal Surgery," May, 1909) it is shown that in 40 cases there were 25 females at 15 males; that the size varies from that of a split pea to enormous dimensional that there may be a pedicle form in front of the vertebral column or from

<sup>\*</sup>St. Louis Med. Review, Dec. 2 and 9, 1901.

intestinal wall; that the sac wall may be exceedingly thin or as much as 1 cm. in thickness; that in some cases large veins are present on the surface of the cyst; that adhesions to the abdominal viscera are common; that intestinal obstruction may occur (kinks, volvulus, intussusception); that cysts are most commonly found in relation with the lower end of the ileum; and that there are no characteristic symptoms except perhaps the rapid body wasting mentioned by Moynihan. Moynihan points out that the cyst fluctuates and is most prominent toward the navel, that it is very mobile, especially transversely (we should add if not anchored by adhesions), and that the cyst is surrounded by a resonant zone and crossed by a resonant band.

Treatment.—Incision and drainage if there are numerous and firm adhesions. Enucleation whenever possible. Resection of the involved portion of gut with the cyst in some cases of multiple cyst (Harry C. Deaver, Ibid.).

## STOMACH AND INTESTINES.

Foreign Bodies in the Stomach and Intestine.—Foreign bodies of considerable size are rarely taken into the alimentary canal except by children, insane people, or drunkards. Small bodies (bits of straw, fragments of bone, etc.) are frequently swallowed. Most foreign bodies swallowed are passed with the feces, but some lodge. Any body which can pass the esophagus is not too large to pass through the intestines. Lodgment is an accident, not an inevitable consequence—an accident which is due to the shape and size of the body. A foreign body may lodge in the stomach. In some cases there are no symptoms. In other cases symptoms are violent. The severity of the symptoms depends upon the shape and character of the body.

In some cases it is possible to feel the body from without. A metal body in the stomach will deflect a magnetic needle held over the viscus (Polaillon). Many foreign materials can be skiagraphed. A body of small Size may pass through the entire canal and emerge without having done any harm, but it may lodge and may cause perforation. If perforation occurs, the foreign matter may become encysted, for instance, in the mesentery; may cause an abscess or may cause general peritonitis. A fish-bone may cause an anal abscess. An epiploic appendix may cause sacculation of the bowel. perforation may take place in this sac, an epiploic abscess resulting, which may attain considerable size and may be mistaken for carcinoma (J. Bland Sutton, in "Lancet," Oct. 24, 1903). It is not wise to attempt to recover a foreign body from the stomach by inducing vomiting. In some cases gastrotomy is necessary. When a small or sharp foreign body has been swallowed and has not caused perforation, abscess, or obstruction, the usual treatment is as follows: a purgative should never be given to expedite the passage of a foreign body, because increased peristalsis means increased danger of impaction or of perforation. Endeavor to encrust the foreign body, and thus lessen the danger of perforation, by feeding with bread and milk only for several days, and at the end of this period give a mild laxative. An exclusive diet of mush or of mashed potatoes has been suggested. Suet dumplings may be given. Pain is relieved by opium. A foreign body rarely lodges in the duodenum, but may lodge lower down, and may cause ulceration, perforation, abscess, or intestinal obstruction. Operation is necessary in such cases.

Volvulus of the Stomach.—This condition is very unusual. Ten cases are on record (Streit, in "Am. Jour. Med. Sciences," June, 1906). One-third of the cases are associated with diaphragmatic hernia. The symptoms come on suddenly with sudden abdominal pain, distention, and collapse. There is nausea, but the patient can neither vomit nor belch. In the upper left abdomen there is a tender, tense, and tympanitic area. The rotation of the stomach may be on its vertical or on its longitudinal axis. An hour-glass stomach may undergo twisting on its vertical or longitudinal axis. Berg operated successfully for volvulus of the stomach. He opened the abdomen, relieved distention by tapping the stomach with a trocar, and then easily corrected the twist. The gastrohepatic omentum should be shortened by

Beyea's operation (page 1091).

Carcinoma of the Stomach.—Innocent tumors and sarcomata occasionally attack the stomach, but they are infinitely rare in comparison with primary cancer. This disease is unusual before the age of forty, and is practically never seen before the age of thirty. It is more common in men than in women, the proportion being as 5 to 4. In a very few instances cancer has been found to have arisen from an ulcer. The forms of cancer which may arise in the stomach are the spheroidal cell growth (either the hard form known as scirrhus or the soft form known as medullary or encephaloid), the cylindric cell growth or adenocarcinoma, and colloid (due to the myxomatous degeneration of either a spheroidal cell or a cylindric cell carcinoma). Scirrhus more than any other form produces constriction of the pylorus and more seldom than any other form produces hemorrhage. It may spread for a considerable distance along the submucous coat, muscular coat, and subserous coat without apparent involvement of the mucus membrane wide of the primary focus of disease. In some cases scirrhus is limited to the pyloric region, in others it is a limited tumor of some other part of the wall of the stomach. In the condition known as "leather-bottle stomach" a scirrhus has invaded the entire stomach wall and the wall of the viscus is thick and rigid.

Medullary cancer and adenocarcinoma produce hemorrhage. Both of these forms most often arise in the pyloric region. Medullary cancer may remain limited, but, as a rule, a cauliflower growth arises and eventually

fills the stomach and portions of the mass may slough away.

Adenocarcinoma is apt to spread along the mucous membrane instead of "infiltrating the deeper layers" as other forms are prone to do ("Cancer and Tumors of the Stomach," by Samuel Fenwick and W. Soltan Fenwick). Spheroidal celled carcinomata are twice as common as cylindric celled and medullary cancer is about as common as scirrhus.

Cancer may be limited to the body of the stomach (either curvature or either wall), the pyloric end or the cardiac end, but it may involve two of these regions, or almost the entire stomach, or, being multiple, may be found in many parts. Sometimes there is a primary cancer on one wall, and another quite due to contact, in a corresponding point of the opposite wall (contact cancer). All forms of carcinoma most frequently begin in the region of the pylorus. In many cases of gastric carcinoma adhesions form between the stomach and the liver, colon, or diaphragm. Even in cancer of the pylorus the duodenum is seldom invaded. Medullary cancer not unusually passes into the esophagus. It is usually fatal in from four months to two years, and

most patients die within one year. In 60 per cent. of cases the pylorus is involved. In over half of the cases of cancer of the pylorus there is no important lymphatic involvement (McArdle). In investigating any gastric disorder follow Mayo's advice and study the history, the size and situation of the stomach, determine the existence and situation of pain and tenderness, the

presence of a tumor, and if the passage of food is interfered with.

Symptoms.—Examine with care a patient in whom cancer is suspected. In unusual cases it produces no symptoms until it has lasted for some time and has attained a large size (latent cancer). In nearly all cases it does produce symptoms. The disease comes on gradually, usually with indigestion and physical weakness. The patient has persistent dragging pain, which is increased by eating and pressure, and attacks of vomiting are frequent. After a short time the patient becomes very weak and exceedingly anemic, and it is often possible to feel a tumor in the stomach. Blood examination shows diminution of red corpuscles and hemoglobin and perhaps absence of any increase of leukocytes after a full meal. The vomiting of gastric cancer is at first only occasional, but as the case progresses it becomes more and more frequent. Vomiting soon after eating occurs when the cardiac region is involved; vomiting an hour or so after eating occurs when the pyloric end is involved. When the body of the organ is the seat of disease, vomiting may be absent. The vomited matter is often mixed with a small amount of altered blood (coffee-ground vomit). In most cases occult blood is found in the feces, especially if hydrochloric acid is absent from the stomach contents. These symptoms associated with "coffeeground vomit" and lactic acid in the stomach contents are strongly indicative of cancer (Wm. J. Mayo, in "Surg., Gynec., and Obstet.," May, 1908). A test-meal is given and important conclusions are sometimes derived from the presence or absence of hydrochloric acid and lactic acid. It is my custom to have the stomach washed out and then have Ewald's test-breakfast given. This consists of one roll of white bread (35 gm.), 400 gm. of H2O, and 400 gm, of tea without milk or sugar. In one hour the stomach is emptied by means of a tube and a pump or a tube and abdominal compression, and the material is examined. If the result of the test seems out of accord with the other symptoms, repeat the process (L. Boas, in "Berlin, klin, Woch.," No. 440, 1905). In most cases free hydrochloric acid is not found in the stomachcontents, but lactic acid is found and Oppler's bacillus can often be detected. There may be red blood-corpuscles in the fluid. If the cancer is not ulcerated, free hydrochloric acid will probably be found; if it is ulcerated, it will usually be absent.\* Free hydrochloric acid may be absent from the stomach because of alrophy of glands, cessation of secretion, or neutralization by the products of the cancerous area. Free hydrochloric acid may be absent when cancer does not exist. I have noted its absence in two cases of cicatricial stenosis of the pylorus.

It may be absent in cancer of the esophagus, advanced Bright's disease, cancer of the duodenum, febrile conditions, and amyloid disease. The constant presence of considerable quantities of hydrochloric acid is strong evidence against the existence of cancer of the stomach. If cancer arises from ulcer, free hydrochloric acid is apt to be present for a considerable time.

<sup>\*</sup> Reissner, in München. med. Woch., Dec. 3, 1901.

Distend the stomach with gas or fluid and map out its a tumor. A tumor can usually be felt if it involves the g anterior wall, and a large tumor of the pylorus can be pal

regions the tumor can rarely be felt.

Cancer of the cardiac end interferes with the entrance stomach, and in such a case the stomach is shrunken and dilated immediately above the growth. In cancer of the partially or completely arrested as it passes to emerge from the stomach becomes much dilated. The vomited matter rarely contains recognizable fragments of the growth, but the stomach has been irrigated may contain pieces which as cancer (Rosenbach).

In cancer of the stomach the general course of the tembut there are occasional deviations to below or above norm the urine contains albumin, indican, acetone, and cancer of the stomach produces spasm of the esophagus, in two cases. Cancer of the stomach is apt to involve so lymph-glands, or organs or other structures, especially the liver is involved in 30 per cent. of the cases (Welch), is enlargement of the supraclavicular glands of the left sidusual and early, but in cancer of the pylorus 60 per cent. of distinct lymphatic involvement. In many doubtful cases of is justifiable.

Treatment.—The medical treatment consists in milk-c morphin and of lavage if the pylorus or body of the stomacl form lavage as follows: The tube for lavage should be lon about three feet out of the mouth when the other end is should be flexible, should have an opening in the stomac opening on the side about one inch above the stomach-end. be greased with glycerin. The patient sits down, throws th the mouth widely, and is directed to take deep breaths a The tube is carried into the pharynx, the patient is ordered swallow it, and the tube is thus taken into the stomach. fluid is poured into the funnel-like end of the tube, and i empties itself of the last of the water the funnel is lowered out. This proceeding is repeated till the fluid becomes cle to use is a solution of bicarbonate of sodium, a teaspoon quart of warm water. Lavage should be practised before sometimes also at bed-time.

The indications for operation are well set forth by Ma progressive aggravation of symptoms in spite of a rigid treatment, loss of gastric mobility, progressive diminution stalsis, progressive diminution of free hydrochloric acid under forced feeding, progressive reduction of hemoglobin under, and moderate leukocytosis.

Surgical treatment aims to remove the growth or to of obstruction at one of the orifices of the stomach.

<sup>\*</sup> John B. Murphy, in Chicago Med. Recorder, June,

In cancer of the body of the stomach, if the growth is not extensive, excision may be performed; if it is extensive, it is useless to attempt it unless the growth is absolutely non-adherent. Conner, of Cincinnati, attempted total excision in 1883, but the patient died on the table. In 1807 Schlatter, of Zurich, successfully removed the entire stomach. Brigham, Richardson, Macdonald, Boeckel, De Carvalho, Bardeleben, Haine, Gallet, Dollinger, Ferry, Ribera, and others have successfully removed the entire stomach and attached the esophagus to the small intestine (complete or total gastrectomy). In these cases digestion was satisfactorily performed after removal of the stomach. Very rarely will cases be found suitable for such a radical proceeding. The case suitable for this treatment is one in which the entire stomach is involved in the growth, in which there is no obvious glandular involvement, and in which the stomach is not adherent, but is freely movable. Herbert J. Patterson ("The Hunterian Lectures for 1906") collected 27 cases of total gastrectomy for cancer: 10 died and 17 recovered. If a small portion of the fundus is left the operation is called subtotal gastrectomy. H. J. Patterson (Ibid.) collected 20 cases of subtotal gastrectomy for cancer with 6 deaths. In limited cancer of the body of the stomach perform partial gastrectomy. In cancer of the cardiac orifice of the stomach the surgeon usually keeps the passage open as long as possible by the frequent passage of a tube, and through this tube introduces liquid food. Sometimes a small tube is introduced and permanently retained. When it becomes difficult to introduce a tube, gastrostomy may be performed. As a matter of fact, in most cases gastrostomy is done as a last resort, and it is scarcely worth doing in cancer of the cardiac end of the stomach. It is far more useful in cancer of the esophagus. In cancer of the pylorus, limited in extent and without lymphatic involvement, pylorectomy may be performed; but in cancer which has widely infiltrated the coats of the stomach and has involved the lymphatic glands, gastro-enterostomy is performed as a palliative measure, the patient during the rest of his life subsisting upon liquid or semiliquid foods and submitting to frequent irrigation of the stomach to remove food-residue. In cases of irremovable and far-advanced cancer it is often best to refuse to operate and to deliberately create the opium-habit in the patient.

The most successful of all the above operations are pylorectomy and partial gastrectomy. The mortality is large. In H. J. Patterson's series of cases the mortality was 28 per cent. There are in literature 43 cases which have survived three years or over (Macdonald). Mayo reported 21 gastro-enterostomies for cancer with 4 deaths. The greatest prolongation of life was nineteen months. His experience makes him question if the operation is worth doing in

malignant disease.

Sarcoma of the Stomach.—Of recent years it has been proved that sarcoma is more common than was once supposed. There are over 60 cases on record. It can occur at any age, but is more usual in early life than is carcinoma. It has been estimated by Wm. T. Howard\* that 37.7 per cent. of cases are under the age of forty, and 11.44 per cent. are under the age of twenty. The pylorus is involved in about one-fourth of the cases. In most cases the posterior wall and greater curvature are involved. Howard says there is a diffuse growth in 21.31 per cent. of cases and that the cardiac end is

<sup>\*</sup> Jour. Am. Med. Assoc., Feb. 8, 1902.

involved in only 4.9 per cent. of cases. Sarcoma arises in the submucous coat. Any form of sarcoma may arise. It causes stenosis in less than one-tenth of the cases. There is no sex predisposition in sarcoma, as there is in cancer.

Symptoms.—A tumor forms, grows rapidly, and often attains a large size, and not unusually actually causes a projection of the abdominal wall. If it ulcerates, there will be hematemesis, but it often does not ulcerate, and bleeding is much rarer than in carcinoma. Not unusually this growth arises in a person under forty, and sometimes in one of less than twenty years of age. Stenosis is uncommon. The liver is involved secondarily in only 11.47 per cent. of cases (Howard), metastases are more rare than in carcinoma, free hydrochloric acid is usually absent from the gastric contents, and microscopic examination of washings from the stomach may detect fragments of sarcoma. Certain diagnosis is impossible without exploratory incision. Howard estimates the average duration of life to be from nine to ten months.

Treatment.—If the liver is free and if there are no metastases, partial gastrectomy or complete gastrectomy may be advisable. If pyloric stenosis

should arise, gastro-enterostomy may be performed.

Ulcer of the Stomach.—Ulcer of the stomach is a condition due to digestion of a portion of the stomach-wall by very acid gastric juice, the destroyed portion having been the seat of lowered vitality. The reason for the lowered vitality of the gastric mucous membrane is uncertain. Thrombosis has been suggested as a cause, but it is rare in gastric ulcer. Embolism is assigned by some as a cause, but emboli are seldom found on pathologic examination. It has been asserted that menstrual disorders may be responsible for ulcer, that tight lacing may be, and that habitually bending over (as in making shoes) may be a cause. The Mayos are of the opinion that the grinding action of the pyloric portion of the stomach may be an exciting cause of ulcer of that region. Some assert that mental anxiety, alcoholism, and syphilis may be causal (Alderson). Ulcers due to syphilis and tuberculosis are not peptic ulcers.

Robson believes that gastric ulcer is septic in origin and that oral sepsis is responsible for its origin in most cases. "Mild sepsis leads to gastritis and hyperchlorhydria, which in its turn provokes and keeps up ulceration" (A. W. Mayo Robson, in "Keen's Surgery," vol. iii). Some observers blame direct damage to the mucous membrane by traumatism or the swallowing of corrosive liquid. The question of cause is involved in uncertainty. What does seem to be certain is that anemia predisposes to the formation of very acid gastric juice (hyperchlorhydria) and to ulceration. In some cases chlorosis is associated

with ulcer.

Ulcers are far more common in females than in males, and are more frequent in young women than in those of middle or advanced age. The acute round ulcer is vastly more common in women. The chronic indurated ulcer is most frequent in men. Men about forty and women between twenty and thirty are particularly liable. There is usually a single ulcer, but in one-fifth of all cases there are two or more, and when there is an ulcer on the anterior wall, it is not uncommon to find one exactly opposite on the posterior wall ("a kissing ulcer" Moynihan calls it). The Mayos divide ulcers into two clinical forms—the indurated and the non-indurated. In the indurated ulcer all the coats of the stomach are involved and the mass of scar tissue indicates

an effort at repair. The most common situation for this form of ulcer is the region of the pylorus (Wm. J. Mayo, in "Jour. Am. Med. Assoc.," Oct. 21, 1905). The non-indurated ulcer involves the mucous coat only and may be of microscopic size, and even a microscopic ulcer may cause death from hemorrhage (Wm. J. Mayo). These non-indurated ulcers exhibit no sign, or almost no sign, on the outer surface of the stomach, and may not be detected even when the stomach is opened by the surgeon. The non-indurated ulcers are divided into the mucous erosions of Dieulafoy, in which the superficial epithelium only is involved, and the true round fissured peptic ulcers (Wm. J. Mayo, in "Jour. Am. Med. Assoc.," Oct. 21, 1905). Both conditions are rare. Ulcers are also divided into acute ulcers, which progress rapidly and produce definite symptoms, and chronic ulcers, which are usually chronic from the beginning, but which may exhibit acute exacerbations, and may have periods of great relief or apparent cure (Wm. J. Mayo, in "Med. Record," August 6, 1904). The most common seats of ulcers are the posterior wall and lesser curvature, especially in the pyloric region; in fact, 80 per cent. occur in the pyloric region. An ulcer may heal or may perforate. Only 2 per cent. of ulcers on the posterior wall perforate, as they tend to form adhesions to adjacent structures (Alderson). Ulcers on the anterior wall are unusual, do not tend to form adhesions, and are apt to perforate. It is not uncommon to have ulcer of the first portion of the duodenum associated with gastric ulcer. Gastric ulcer is at least four times as frequent in England as in the United States. In 2830 autopsies made in the Philadelphia Hospital there were 40 gastric ulcers, and in 3763 autopsies made in four Philadelphia institutions there were 51 gastric ulcers—a percentage of 1.35 (see A. P. Francine, in "Proceedings Phila. Co. Med. Soc.," March 31, 1905).

Symptoms.—In an acute ulcer the symptoms are often typical; there are pain, tenderness on pressure, slight or distinct unilateral muscular rigidity, vomiting, hemorrhage, and hyperchlorhydria. In a chronic ulcer the symptoms may be clear, may be misleading, may be variable, and in some cases even absent (latent ulcer). In ulcer dyspepsia usually exists. It is usually but not always acid dyspepsia and is associated with much flatulence. In most cases, though not in all, food aggravates the condition. There is a gnawing sensation (hunger pain) when the stomach is empty, and may be actual pain. The taking of food may temporarily relieve pain, while as quantities of gastric juice are poured out to digest the food the pain increases. If hyperchlorhydria disappears (as it may do from chronic gastritis and does do from gastric dilatation following pyloric obstruction), pain may not be increased during digestion. In ulcer of the cardiac and lesser curvature gnawing uneasiness is but briefly or not at all relieved by taking food and pain develops immediately or almost at once. In ulcer of the pyloric region the gnawing uneasiness may be distinctly relieved by taking food, but in two or three hours pain is apt to become severe. In ulcer the pain is paroxysmal. It is at times very violent in the epigastric region, and also passes to the back, being located between the eighth and ninth dorsal vertebræ.

In gastric ulcer it is usual to find distinct or severe tenderness developed by epigastric pressure, and tenderness is associated with more or less rigidity. In ulcers of the anterior wall tenderness is most acute. In many of these patients vomiting occurs about two hours after eating. The vomited matter, as a rule,

contains much hydrochloric acid. Vomiting often relieves of the gastric contents after the administration of a test n 80 per cent. of the cases hyperacidity. Obvious hemorrha occurs in less than one-half of the cases, and from 3 to actually die of hemorrhage. Wm. J. Mayo states that "me of hemorrhages from the stomach are from chronic ulcers ulcer history" ("Surg., Gynec., and Obstet.," May, 1908). brought up with food, and is then black and clotted, or m and in large amount. Blood may be present in vomited such small amount that its presence is observed only by th demonstration in the feces of minute quantities of blood portant diagnostically. It may be demonstrated by the g aloin test. For two days before this test the patient mus sausages, or fish. Blood in the stools does not prove the ulcer. It may come from any spot from the mouth to the Mayo says ("Surg., Gynec., and Obstet.," May, 1908): blood in the stool affords proof as to the fact that there is never be lost sight of that it bears with it no evidence as intestinal origin. The patient may have bleeding gums of some slight abrasion in any part of the many feet of mucou exist between the lips and the anus. If occult blood is for test, it must be corroborated by others, as some unsuspected give rise to the reaction.

"As a matter of fact, hemorrhage from ulcer is by no occurrence. The base of the ulcer is clean and free from g that bleeding may be infrequent. Careful examination of days may be necessary to detect its presence."

In hemorrhage from an acute ulcer a pint or two may be utes, and such a patient presents all the general symptoms of rhage. In some cases blood from the stomach is passed part or wholly. A very large hemorrhage may occur, as never be repeated, or a large hemorrhage may be followe the first of three or of a series. In a great many cases after there is no further bleeding or there are subsequently a rhages. Small hemorrhages may occur indefinitely, and eventuate in a large hemorrhage. In chronic ulcer in v rhages recur over a long period the condition is due to gested mucosa or to the erosion of small vessels which retract because they are imbedded in fibrous tissue. A may be due to the erosion of a large vessel, but is ofte existence of a great number of erosions of the mucous i perhaps so numerous that blood seems to pour from every po surface. It is usually stated that in a sudden acute violen will probably be no history of antecedent stomach trouble is of the opinion that "a single hemorrhage from a patie previous gastric symptoms is probably not due to ulcer" ( Obstet.," May, 1908). It may arise from rupture of veins from blood from hemoptysis being swallowed.

In a chronic ulcer it is sometimes, though seldom, possible to palpate the indurated area.

Constipation generally exists. There is usually very marked anemia aggravated and, some think, occasionally caused by continued loss of blood. Indigestion aggravates anemia and also may cause it. There is loss of weight. There is often a tender area in the back a little to the left of the ninth and tenth dorsal spines. A triangular area of hyperesthesia is often found in the left epigastric region (Head).

If the ulcer does not cicatrize, but progresses, causing pain and hemorrhage, the patient becomes thinner, more anemic, weak, and even exhausted.

It is certain that many cases of gastric ulcer are unrecognized; in fact, as Habershon says, diagnosis is rarely made unless hemorrhage exists, and in certain latent cases both vomiting and bleeding are absent. It is believed by some that latent ulcers are even more common than are ulcers causing symp-

some that latent ulcers are even more common than are ulcers causing symptoms. Hall ("Am. Jour. of Med. Sciences," May, 1909) says: "Rather than look too narrowly for exactly this or that evidence, we should take the broader ground that ulcer probably exists in most patients complaining of persistent indigestion, even though not of an acid character, if pain, tenderness, vomiting, and rigidity, or two or three of these phenomena be present, and even

though hyperacidity be not proved."

A gastric ulcer may cicatrize and thus be cured, but the cure of the ulcer may prove the ruin of the stomach by producing stenosis of one of the stomach orifices or hour-glass contraction of the body of the stomach. An ulcer may perforate and does so in about 15 per cent. of cases (Robson). A perforation may be acute; that is, the ulcer suddenly breaks open when the stomach contains food or liquid, and the contents of the stomach are poured into the free peritoneal cavity. A subacute perforation occurs when the stomach is empty or nearly empty. The opening is small in size, there is no escape of stomach-contents or the escape of only a small amount, and the opening may be quickly closed by adhesions to an adjacent surface of peritoneum or a piece of omentum. If a certain amount of stomach-contents is extravasated, it is usually surrounded by adhesions or tracks slowly toward the pelvis. In what is known as a chronic perforation the break takes place usually in the posterior wall into a box of preformed adhesions, the extruded gastric contents are circumscribed by these adhesions, the general peritoneal cavity is not invaded, but circumscribed suppuration is inaugurated.\* This condition is known as perigastric abscess, and the subphrenic form is the commonest. In such a case the abscess may break into the pleural cavity or even into the lung. I recently operated on a girl of sixteen and found a perigastric abscess and a perforation of the anterior wall near the pylorus, and this Condition was tuberculous. A fistula persisted for months, but finally healed.

Perforation is usually brought about by muscular effort and is most common after a full meal. The real cause is spasm of the pylorus which causes tension of the stomach walls and keeps the viscus from emptying. Pyloric spasm is very common in sufferers from ulcer. In acute perforation food is the most active cause, in chronic perforation, muscular effort. "The severity of the symptoms depends upon several conditions: the previous state of health, the size and number of the perforations, the condition of the stomach, whether full or

<sup>\*</sup> See paper by B. G. A. Moynihan, Brit. Med. Jour., Jan. 31, 1903.

almost empty, the bacterial virulence of its contents, vomiting."\* The situation of the ulcer has some influ "If in the fundus, at the cardiac end, or in the body of infection of the whole peritoneal cavity rapidly follows pylorus or in the first portion of the duodenum, the the right side of the abdomen, owing to the hillock for mesocolon at the pyloric end of the stomach" (Moy Jour.," Jan. 31, 1903). In such a case the fluid may griliac region and the condition may be mistaken for app subacute gastric perforation I operated, believing the Alderson calls attention to the fact that the sudden pay be mistaken for poisoning, and he cites the death of Orleans, in 1670.

Acute perforation can usually be certainly diagnostiearly. Such an emergency has usually, but not inv by positive and prolonged symptoms of gastric disord and violent epigastric pain, greatly increased by swalle ing, and by pressure. This pain may radiate through the chief tenderness is in the region of the stomach. after perforation does not of necessity correspond to The collapse is usually profound. In some cases dea but, as a rule, reaction occurs and peritonitis develops. rupture. When it does occur, it does much harm by by ejecting gastric contents into the peritoneal cavit is very unusual. Board-like rigidity exists, and it is mo portion of the abdomen. The area of liver-dulness is ished or obliterated. If a patient with acute perfor operated upon, he will soon exhibit the symptoms Subacute perforation causes less violent symptoms ar gradually. There is in the beginning severe but not gradually abates. Moynihan points out that there is several days before the perforation. Peritonitis de Gibbon says, the chief symptoms are often pelvic. C. the signs and symptoms of perigastric abscess.

Treatment.—Medical Treatment of Non-perforate. It is necessary to abandon stomach feeding for a time, give nothing whatever by the mouth and give an enema salt solution every six hours. This is preferable to a nevery time a nutritive enema is given a flow of gastric justomach (see W. Pasteur, in "Lancet," May 21, 1904; and in "Lancet," Nov. 10, 1906). During this treatment comfortable and is not unbearably disturbed by hung end of a week or ten days pancreatinized or peptonized by the mouth, or else nutritive enemata are substituted are given for a few days before stomach feeding is in feeding has been abandoned the patient is placed on a ably pancreatinized milk, and lavage is given twice a

<sup>\*</sup> Moynihan, in Brit. Med. Jour., Jan. 31,

Carlsbad salts are given (Ziemssen); to others silver nitrate, bismuth subnitrate, or oxalate of cerium. If pain is severe, opium may be required. Many cases are apparently cured by medical treatment. Russel's statistics show that 40 per cent. of cases were reported cured under medical treatment, but no one knows how many of those reported cured again gave evidence of the disease or later perished of hemorrhage or perforation. Further, 18 per cent. of the 500 London Hospital cases under medical treatment died.

Surgical.—Following the Mayos, we would not advise surgical treatment in acute ulcers unless complicated by hemorrhage, perforation, or obstruction; or in chronic ulcer, until careful medical treatment has failed. Operation is indicated for chronic ulcer when a mechanical cause is responsible for retention and stagnation of stomach contents, and in certain cases of hemorrhage. Operation is also indicated in chronic ulcer with frequent exacerbations, but the surgeon must be very chary of operating upon neurotic women with gastroptosis, unless, of course, there is a positive indication (Wm.

I. Mayo, in "Jour. Am. Med. Assoc.," Oct. 21, 1905).

In a chronic ulcer if the patient grows worse in spite of careful dietetic and medical treatment, if hemorrhage has been profuse or if there have been frequent distinct hemorrhages, if the pain is violent, or if tenderness is marked, open the abdomen and inspect the stomach. An ulcer with indurated edges is easily found. The form, called by the Mayos the non-indurated ulcer, gives no evidence or little evidence of its existence when the outer coat of the stomach is felt and inspected (Wm. J. Mayo, in "Jour. Am. Med. Assoc.," Oct. 21, 1905). Even when the stomach is opened, no ulcer may be found. According to Mikulicz, in some mucous ulcers there is a very little thickening, and, according to Moynihan, the mucous coat may be a little adherent to the muscular coat, so that it does not slide easily. An enlarged gland in a portion of the omentum may be a sign of ulcer (Lund). An indurated ulcer may be removed by an elliptical incision in the long axis of the stomach, the coats being sutured by the usual method, and gastro-enterostomy being also performed. In some cases gastro-enterostomy alone leads to the cure of chronic ulcer. The Heineke-Mikulicz operation is not satisfactory in ulcer. Finney's gastrod uodenostomy is not advisable if there is an unhealed ulcer, because food still passes over the ulcer after its performance (Wm. J. Mayo).

Operation for Gastrorrhagia (Hemorrhage from the Stomach).—Rydygier proposed in 1882 to operate for hemorrhage. The first operation was done by Mikulicz in 1887, and the first successful operation was reported by Roux

III 1803.

In an acute and violent hemorrhage threatening life the proper course to pursue is somewhat uncertain. It is not proper to operate if there has been but one hemorrhage, because the chances are that the bleeding will not be repeated. Again, the chance of arresting such a hemorrhage by operation is, on the whole, poor. The danger of waiting after one hemorrhage is not so great as the danger of immediately operating, because collapse antagonizes renewed hemorrhage, but adds enormously to the risk of an operation. In over 90 per cent. of cases the hemorrhage ceases spontaneously. In over 18 per cent. of those dying of hemorrhage death is so rapid that operation is impossible (Savariaud). If the bleeding is from a distinct ulcer, we may succeed in excising the ulcer or in ligating the bleeding-point. Roux, of Lausanne,

saved a patient by excising an ulcer and ligating the b on each side of it. As a rule, however, the bleeding is n but from a multitude of excoriations. In the light of we may lay down the following rule: Do not operate for Simply bring about reaction by gentle means, let the pat give suprarenal extract by the stomach. If the bleed in comparatively trivial amounts, do not operate; but i should advise operation. In cases of ulcer in which blo persists, operation is indicated. In operating for a sev geon opens the abdomen while hot salt solution is be The stomach is opened, the clots washed out, and a sea of the blood. If it is found that the blood comes from an area may be extirpated, ligated, or cauterized with the advise surrounding it with a purse-string suture. Oth simply perform gastro-enterostomy, which is of service rest to the dilated stomach, the hemorrhage being perha tion of the gastric walls and the rest secured prevent hemostatic clot. Gastro-enterostomy is of most ser pylorus and in duodenal ulcer. If the ulcer is well abo be excised if possible. As a rule, it will be found the the ulcer are varicose. Excision is indicated because excision is impossible "the main blood-vessels leading ligated and the peritoneum and muscular coats drawn of in "Surg., Gynec., and Obstet.," May, 1908). If it i ing comes from a multitude of excoriations and that ti nihan expresses it, "weeping blood," we can do no ostomy, which in such a condition is of uncertain value

Operation for Perforation.—In acute and subacute once, having all proper means taken to bring about rea the abdomen is being sterilized and while ether is b saline enemata, external heat, atropin hypodermatics advised to wait until reaction was established before believe such advice erroneous. To delay after an acu for what may never come. Open the abdomen at the derness, or, if there is no such point, open it in the e to the right of the midline. When the abdomen is an escape of odorless gas, and food or fluid may be toneal cavity. The perforation is sought for and i anterior wall. When found, it should be buried an wall, a portion of which must be inverted by two lay I do not believe that excision or paring the edges is in a case of perforated ulcer. If no perforation is four make an opening into the lesser peritoneal cavity t omentum, explore the posterior wall, and close and found. In addition to closing the perforation, gastroically indicated in order to drain the viscus, give it res ency to recurrence of ulceration. But, as a matter of f. return. The patient is usually too severely shocked to re operation justifiable, and I agree with Gibbon that such

performed only when there are multiple ulcers or when there is pyloric constriction (John H. Gibbon, in paper before the Tri-State Med. Assoc. of Virginia and the Carolinas, Feb. 23-24, 1904). After closing the perforation the abdominal cavity is irrigated with hot salt solution and the space between the liver and diaphragm is sponged out with a gauze pad wet with hot salt solution. If the case is operated many hours after the perforation, or if the peritoneum was badly soiled, drainage must be used, but even in other cases it is safest to use it. Drainage is obtained by means of a strand of iodoform ga uze passed to the suture line in the stomach. In cases with much extrava sation, especially if the extravasation has reached the pelvis, a suprapubic opening is made and a tube inserted. After the patient has reacted from the shock of the operation he should be placed in a semi-erect position to direct the flow of infective material to the pelvis, and continuous proctoclysis should be employed as in peritonitis (page 1006). The treatment of chronic perforation is the treatment of perigastric abscess, and consists of incision and drainage. Of late, a number of cases of acute and subacute perforation have been successfully operated upon. Moynihan estimates that 35-40 per cent. of acute perforations recover after operation. T. Crisp English ("Lancet," Nov. 28, 1903) reported 42 consecutive gastric perforations

operated on in St. George's Hospital. Twenty-two recovered.

Cicatricial stenosis of the orifices of the stomach results from the healing of an ulcer, the swallowing of a corrosive substance, or traumatism from a foreign body. Constriction of the cardiac orifice is indi-Cated by gradually increasing difficulty in swallowing. After a time the sophagus above the stricture dilates or pouches; the fluid food passes into the stomach, but the solid food lodges in the esophageal pouch and is Soon regurgitated. The site of the stricture is located by a bougie, and by having the patient swallow while auscultating over the esophagus and Cardiac end of the stomach. If the constriction be malignant, the patient be found to be beyond middle life, the vomit is occasionally bloody, emaciation is rapid and decided, and occasionally the supraclavicular glands are enlarged. A tumor of the cardiac end of the stomach can seldom be Palpated. If the constriction be cicatricial, the history will indicate the Constriction of the pyloric orifice causes retention of food and dilatation of the stomach. Dyspeptic symptoms will be found to have been long Present. A tube passed into the stomach permits of the injection of fluid so as to fill the stomach. When the fluid runs out, it contains portions of undigested food, which was perhaps eaten days before, and measurement of the liquid shows that the capacity of the stomach is enormously increased. If hydrogen be forced through the tube, the outline of the distended stomach is at once made clear. The usual method of distending the stomach is by a Seidlitz powder: two solutions are made; the bicarbonate solution is swallowed at once, and the tartaric solution is taken afterward in small amounts at a time. Percussion over the distended stomach indicates the size of the viscus. It is well to remember that dilatation of the stomach can occur without cicatricial stenosis when gastric ulcer exists. The cause in such a case is pyloric spasm or perhaps the atonic condition which may result from anemia

In malignant disease of the pylorus a tumor may often be palpated; there

are tenderness and considerable persistent pain, greation, absence of free hydrochloric acid from the gastric corpuscles and hemoglobin, and no increase of white meal. There is sometimes enlargement of the supracliting of bloody fluid occurs in 40 per cent. of the malition of the stomach by the gastrodiaphanoscope may area of malignant growth interfering with the transmitricial stenosis of the pylorus there may be paroxysms derness, emaciation is not so rapid in onset, and the are never enlarged. Vomiting occurs, but the ejecte

Treatment.—Cicatricial cardiac stenosis requires and the maintenance of the restored caliber. If di unsatisfactory, perform a gastrotomy, push a small into the stomach, tie a string to the bougie, draw stricture, use the string as a saw to cut the fibrous bougie, close the wound in the stomach, and main cardiac orifice by the repeated passage of dilating inst ment can be passed through the stricture from above, introduce an instrument from below and pass it into the draw the string into the stomach, and use Abbe's string instrument can be passed from below, convert the trostomy. In malignant stenosis of the cardia gastro all, should be performed early. Cicatricial pyloric st by a gastrotomy and digital divulsion of the strictu but this operation is obsolete, experience having sh is inevitable. Pyloroplasty was until recently advoca This is known as the Heineke-Mikulicz operation. cases the symptoms are not relieved by pyloroplas renders gastro-enterostomy necessary. Mayo points pyloroplasty fails because the pylorus is on a higher pouch, the degenerated muscle of the stomach is from the pouch to the pylorus, and the symptoms of retardation of the passage of food into the duodenum operation has been generally abandoned. Finney's denostomy (Figs. 552, 553, 554, and 555) is a great in plasty. The opening is large and in a proper position drainage. Gastro-enterostomy is the most satisfact cases and usually effects a cure. Malignant stenosi tomy or gastro-enterostomy. (See under these head

Congenital or Infantile Hypertrophic Steno Stenosis of the pylorus in adults is almost invariably dibut in very young children one occasionally meets with ital. The history of such a case is that during the lafter birth the child seems in every way normal, but number of days or weeks vomiting suddenly begins—dietary cause seems responsible, and which persists iro After the stomach has been emptied by vomiting the lieved, but when, after a time, food is administere again, either in a very short time or after an hour or

that the vomited matter in congenital stenosis of the pylorus never contains any bile whatever, for obvious reasons—the pylorus is shut and the bile cannot enter the stomach. A child in this condition receives little or no nourishment, becomes quickly emaciated, and soon dies. Some of these children die in a month; others, in several months; and a few may live for five or six months. It may be possible, in these cases, to palpate a thickened pylorus; and the outlines of the dilated stomach can probably be made out. The most common symptom is gastric peristalsis. In Bunts' table gastric peristalsis was present in 84 per cent., and tumor in 69 per cent. of cases. The intestines are very much collapsed, and the child is, of course, very much constipated. Cases have recovered after lavage carried out daily for some weeks and careful breast feeding. A trial should be given this method unless the condition of the patient demands immediate relief. The delay in employing surgery in hopes of lavage succeeding must never be so long that the patient emaciates. If his condition does not soon show signs of improvement, operation is indicated. Some of the cases reported cured by medical means may have been instances of pyloric spasm. The operation for this condition is usually gastro-enterostomy. The mortality after the operation is apparently over 50 per cent. It is superior to pyloroplasty because it enables us to at once Feed the exhausted child.

Perigastric Adhesions.—That perigastric adhesions are frequently responsible for stomach pain and digestive difficulty is undoubted. Such adhesions often arise in cases of protracted ulceration of the stomach or cludenum. A common cause of perigastric adhesions is gall-stone disease. Tuberculous peritonitis causes dense adhesions. In some cases the adhesions are traumatic, in some they are due to syphilis, in many the cause is uncertain Fred. D. Bird, "Intercolonial Med. Jour. of Australasia," Dec. 20, 1900). Adhesions may cause blocking or kinking of the pylorus, or may glue the tomach to the parietal peritoneum or to some adjacent viscus. In Fenwick's able of 123 cases he finds that the adhesions usually cause the stomach to the pancreas or to the liver. The formation of adhesions in cases gastric ulcer is, in many instances, conservative, serving to prevent perforation or to limit extravasation if perforation of the stomach-wall occurs.

Symptoms.—The symptoms are variable. In some cases the adhesions produce little or no trouble; but in the majority of cases they cause definite mptoms, and sometimes the condition becomes one of absolute disablement. The symptoms may be due to blocking of the pylorus, a condition that is followed by gastric dilatation. They may be due to dragging upon the adhesions, when the stomach contracts during digestion, or when perisalsis occurs in an adherent piece of intestine.

The usual symptom is pain, frequently of a violent character. The pain comes on in paroxysms, and recurs over and over again, it may be during years. H. Hale White\* points out that in these cases there is usually some pain persisting, which is now and then increased into violent paroxysms; and that the only other condition that produces persistent pain with violent exacerbations is cancer. In adhesion-dyspepsia, however, there is no distinct loss of weight; the condition may exist in youth, as well as in middle age or old age; it is

<sup>\*</sup> Lancet, Nov. 30, 1901.

not increased by taking food; and it very rarely can a history of antecedent gall-stone disease or of ulcer of sible to make the diagnosis without exploratory operases the condition may sometimes be diagnostical there are these attacks of violent pain, there is no ten the adhering and matting together with inflammato palpable mass. In doubtful cases of chronic and distant exploratory operation should be performed; if ad then become manifest.

Treatment.—In some cases simply dividing an a in other cases it is necessary to make extensive separatures, covering the raw surface with omental grafts. about the pylorus gastro-enterostomy is usually the pro-

Bilocular Stomach (Hour-glass Stomach).—some cases are congenital, but the writings of Mayo Rol L. Patterson cause us to gravely doubt if it is ever cong called congenital cases ulcers are found, or ulcer scars are demonstrable. The advocates of a congenital or are secondary to the narrowing, and that ulceration tenat the seat of constriction. Beyond doubt, a very gre cases of bilocular stomach result from adhesions produculcer. In hour-glass stomach with a large opening bet may be no symptoms. When the opening is small, those of pyloric stenosis. The sac toward the card dilated.

Symptoms.—The diagnosis of cancer is often a gastritis may have caused free hydrochloric acid to of fermentation are usually found. The patient von bringing up food which was eaten a day or two bet retained in the stomach and not digested. Occasio vomited. There is pain and the patient is harass eructations. Emaciation is pronounced. Cumston p belly distention of the stomach may make the conthat if water is thrown into the stomach, only a part stomach is emptied as much as possible by a tube, a sple elicited in the stomach because the pyloric pouch is no death is torsion on the axis.\*

Treatment.—The diagnosis becomes certain only tion, and exploration also enables the surgeon to de to what operation should be performed. Cumston suggestions:

1. In rare cases resect the stricture and suture the

 If there is trivial ulceration or a slight scar, do ga upon the constriction exactly similar to pyloroplasty.

The best operation in most cases is gastrogast tomosis of the cardiac pouch to the pyloric pouch; be if the pyloric pouch is small. Then do gastro-enterosi

<sup>\*</sup> Cumston, in Med. News, Dec. 190

Other operations are:

- 4. Gastroduodenostomy.
- 5. Gastrojejunostomy.
- 6. Gastrolysis.\*

In malignant disease resection (partial gastrectomy) is indicated. After gastroplasty recontraction is common, but I do not believe in the operation. Castro-enterostomy is unsatisfactory. The ordinary operation drains but one pouch. Weir and Foote advised a double gastro-enterostomy, tapping each sac. In most cases gastrogastrostomy followed by gastro-enterostomy is the

best procedure.

Chronic Dilatation of the Stomach.—A dilated stomach, roughly speaking, is one which can contain more than 1.5 quarts (Ewald). Some few cases of dilatation result directly from atrophy of the muscular coat, brought about by drinking quantities of liquid, especially beer; chronic catarrh of the stomach; and conditions such as cancer, tuberculosis, diabetes, etc. The common cause of dilatation is constriction of the pylorus. In order to force food by the pyloric narrowing more force is necessary than is required in a normal state of affairs and the stomach muscle hypertrophies. This muscular hypertrophy is compensatory, and dilatation does not occur so long as the muscle is efficient. But finally the pyloric opening becomes so narrow that compensation fails, the stomach-contents accumulate, and the stomach dilates.

Symptoms of Dilated Stomach.—There is annoying hunger unless cancer exists. Thirst is complained of. At intervals of a day or two the patient vomits enormous quantities, and portions of food may be identified which were eaten several days before. The vomited matter is sour and foul-smelling, contains numbers of yeasts and much fermentative acid. Free hydrochloric acid is often absent. In some cases vomiting occurs two or three hours after each meal. The patient suffers from foul gaseous eructations. There are progressive emaciation, constipation, scantiness of urine; sometimes cramp in the legs, belly, and arms; tetany may occur; insomnia is the rule; cardiac palpitation occurs, and there is dyspnea, particularly at night.

Physical Signs of Dilated Stomach.—The epigastric region is hollow and the left side of the abdomen is more prominent than the right. The outline of the greater curvature of the stomach can be distinguished. If the stomach contains air, percussion gives a tympanitic note; if it contains fluid, a dull note. When it is partly full of fluid, by altering the position of the patient we can show by percussion that the fluid changes its position. In a doubtful case give a light meal in the evening, and in the morning, before the patient has eaten, introduce a tube and remove any material contained in the stomach. The presence of undigested food points to dilatation.

To Test the Motor Power of the Stomach.—Klemperer's Test.—Wash out the stomach. Introduce 100 c.c. of olive oil by means of the tube. After two hours withdraw the oil. The stomach cannot absorb oil, and if the amount withdrawn is subtracted from the amount introduced, the difference is the amount which passed the pylorus. If the condition is normal, not more than from 20 to 40 c.c. should be found in the stomach after two hours.

<sup>\*</sup> Med. News, Dec. 7, 1902.

The Salol Test of Ewald.—Salol is not decomposed in in the intestine is broken up into phenol and salicylic acid. absorbed and salicyluric acid soon appears in the urine. If the intestine, salicyluric acid will not appear in the urine the intestine more slowly than normal, salicyluric acid a longer interval than when there is no pyloric block to ret of the stomach. In a normal person salicyluric acid is for in from three-fourths of an hour to an hour after swallowing In stenosis of the pylorus it appears much later. The test is The bladder is emptied and the patient is given three cataining 5 gr. of salol. The patient is directed to pass wate until he has done so four times. Each sample voided is cyluric acid by adding neutral chlorid of iron. If salicylur a violet color is noted.

To Test the Absorptive Power of the Stomach. power of the stomach can be tested by giving the patient a criz gr. of iodid of potassium. Normally the drug should saliva in from ten to fifteen minutes. When absorption is not appear for an hour or longer. In order to test for it, mowith the saliva and touch the moist paper with a drop of it is in the saliva and the saliva an

While the diagnosis of dilatation of the stomach can be the determination of the cause may require an exploratory of

Treatment.—Cases not due to pyloric obstruction are by lavage, regulated diet, use of an abdominal belt, elecand other agents called for by symptoms.

In all cases where there is pyloric obstruction, in mar and in cases in which medical treatment fails, exploratory cated. In dilatation without pyloric obstruction some s gastroplication. If pyloric obstruction exists, the surgeon pylorectomy, pyloroplasty, or gastro-enterostomy, the me pending on the condition discovered. If gastroptosis exis

Beyea's operation may be performed.

Acute Dilatation of the Stomach.\*—This condition in the course of chronic dilatation or when no previous. Its clinical features were described by Brinton in 1859. Hil furnished us with the first comprehensive description of the toms. The cause is uncertain, and is a subject of active in present time. It is said to be due to degeneration of the the course of specific fevers, to paresis arising in the course of and to the drinking of a quantity of effervescing liquid. I fatal sequence of abdominal operations, particularly operational bladder and bile-ducts. The surgeon sees it in the course of shock from operations in which a general anesthetic was used in cases of spinal curvature.

One set of observers maintains that the condition is broug constriction of the duodenum, the constricting cause bein

<sup>\*</sup> See Kelling, in Archiv. f. klin. chir., 1901, lxiv; Albrecht, in 1899, clvi; Conner, in Am. Jour. Med. Sciences, March, 1907.

mesentery and the superior mesenteric artery and the duodenum being squeezed against the vertebral column (Rokitansky, Albrecht, Robinson, and Kundrat). Codman believes that normally in man there is more or less tendency to such constriction on standing erect or lying down and that a trivial increase of the constriction which may be brought about by various causes may completely obstruct the duodenum ("Boston Med. and Surg. Jour.," 1908). Conner collected 18 fatal cases shown by necropsy to be due to mesenteric obstruction (Lewis A. Conner, in "Am. Jour. Med. Sciences," March, 1907).

Another set of observers assert that acute dilatation is due to lesion of the nerve trunks or nerve centers, resulting in paresis of the muscle of the stomach wall and spasm of the pylorus. The cause of the nerve lesion is variously held to be hyperacidity of gastric secretion, the absorption of the toxins of fermentation, the secretion of chloroform into the stomach, the overdistention of the viscus with ether vapor, and the enormously great secretion of fluid into the stomach.

As Conner says (Ibid.), the theory of pyloric spasm being causative is untenable because in most cases vomited matter contains bile and in two-thirds of the cases the duodenum is certainly involved in dilatation.

It seems certain that some cases of gastric dilatation are associated with mesenteric constriction of the duodenum, brought about by the intestines descending into the pelvis. The constriction inaugurates the dilatation and is aggravated by the dilatation. Conner points out that the intestines enter the pelvis as a result of dorsal decubitus, a long mesentery, and a gut nearly empty of gas and feces, and is favored by relaxation of the belly wall ("Jour. - Am. Med. Assoc.," March, 1907).

Symptoms.—The most frequent and prominent is violent vomiting, usually inaugurating the symptoms and continuing throughout the illness, although occasionally it ceases for some time before death. The amounts vomited are large and often enormous. The vomitus is thin and of a green or black hue, usually contains bile and sometimes a little blood, but very seldom feces.

In most cases, but not in all, there is epigastric or umbilical pain and tenderness. Distention is the rule. Rigidity is rare. In many cases there is no passage of gas or feces, but in some diarrhea exists. There is great thirst, there may be hiccough, and delirium may arise before death. The temperature is nearly always normal or below normal. There is seldom visible gastric peristalsis (Conner, Ibid.), and splashing sounds are obtainable over the stomach.

Collapse arises early and quickly becomes profound. Tetany occasionally occurs. A case of my own died of acute gastric dilatation after an operation for stone in the kidney. He suddenly developed attacks of violent and profuse vomiting, rapidly went into collapse, lividity developed and hiccough arose, and he died in forty-eight hours.

A case may die in less than twenty-four hours or may die after ten days or more. Conner's group of cases show a mortality of 72.5 per cent. Fluid cannot reach the small intestine, and as none is absorbed from the stomach and little from the duodenum, the tissues starve for the want of it (Laffer, in "Annals of Surgery," April, 1908). The condition is frequently diagnosticated acute intestinal obstruction or peritonitis from perforation.

Treatment.—When the stomach has dilated greatly and when collapse is profound, treatment is usually of no avail. When an early diagnosis is made treatment is often of the greatest value. The stomach must be at once emptied by the use of a tube and the treatment be repeated at intervals of a few hours. Neither food nor drink should be given by the mouth. Saline enemata and perhaps nutritive and stimulating enemata should be given. The patient should at once be placed upon the belly and kept there until the condition abates, in the hope that this posture will relieve duodenal constriction.

Gastro-enterostomy has been employed, and is advocated by Mayo Robson. Byron Robinson had a successful case. I would be disposed to employ it in spite of the reported failures. In a number of cases the stomach has been opened and washed out without benefit. Petit opened the abdomen and discovering a kink at the junction of the duodenum and jejunum, he raised the jejunum and sutured it to the transverse colon and the patient recovered

(Conner, Ibid.).

Not until we know definitely the cause or causes of acute dilatation of the stomach will we be able to lay down with precision and accuracy the treatment which is indicated. There is much difference of opinion as to the causation of the condition and widely different methods of treatment are

advocated by various surgeons.

Gastroptosis.—In this condition the stomach has undergone displacement downward, the greater curvature in many cases being but little above the pubic symphysis and the lesser curvature being between the ensiform cartilage and the umbilicus. This condition is far more common in women than in men, and is especially common in women who have had many children. It may be produced by tight lacing and may follow movability of the right kidney, of the liver, or of the spleen. It is often associated with enteroptosis and is particularly prone to arise in the anemic and tuberculous.

Symptoms.—There may be no symptoms for a long time, but sooner or later dyspepsia arises because the stomach cannot empty itself. The stomach becomes atonic, its secretions are scanty and altered, and while the viscus may be normal in size or even shrunken, it is usually dilated. The malposition can be made out by percussion when the stomach is distended with air or with fluid.

And by the x-rays after the patient has drunk a pint of a solution of mucilage of acacia containing subnitrate of bismuth. The bismuth lines the stomach and intercepts the x-rays and a radiograph shows the outlines of the stomach and hence its size and position. The pylorus descends to the umbilical region, which it does not do in dilatation. In dilatation the pylorus is but slightly lower than normal, but the lower border of the stomach is notably depressed.

When a patient with gastroptosis stands erect the bulging is most prominent in the region of the umbilicus and the epigastrium is deepened.

Gastroptosis is not infrequently associated with chlorosis.

Treatment.—Lavage, regulation of diet, improvement of the general health, and the wearing of an abdominal binder. If medical treatment fails and the condition is producing grave impairment of the general health, it may be necessary to perform a surgical operation. Gastro-enterostomy is advocated by some on the ground that the unpleasant symptoms result from stag-

nation of gastric contents. Good results have been reported by this plan. The operation of Depage is unphilosophical. Duret's operation is objectionable (page 1090). Beyea's operation is usually preferred (page 1091).

Intestinal Obstruction (Ileus or Enterostenosis).—Intestinal obstruction is a condition in which fecal movement is mechanically impeded or prevented. It may be either partial or complete. Acute obstruction is due to a sudden narrowing or occlusion of the lumen of a portion of the intestine. Chronic obstruction is due to a gradual narrowing of the lumen of a portion of the intestine, and it may at any time become acute. If obstruction to circulation in the wall of the bowel occurs, the condition becomes one of strangulation. In acute obstruction the stagnated intestinal contents become charged with powerful poisons which act most harmfully on the musulature of the intestinal wall, and, after absorption, attack the heart and pervous system. The inaugural shock is due to the production of the block, the later increasing depression is due to absorption of poisons. Gas forms in great amount in the intestine and produces distention. Distention impairs the circulation in the wall of the intestine and embarrasses respiration by pushing up the diaphragm. Intestinal obstructions are classified\* as follows:

1. Strangulation by bands or in apertures, the commonest form, is due to peritoneal adhesions, but the band may come from the omentum. Strangu-La tion by bands or in apertures usually involves the ileum and sometimes the colon. This form of obstruction is identical with hernia, except in the absence of an external protrusion. Obstruction may take place by Meckel's diverticzel zem (page 973), a structure due to persistence of the vitelline or omphalomesenteric duct, coming off from the ileum from 12 to 36 inches above the ileocecal valve, and present in about 2 per cent. of persons. The vitelline duct should be obliterated in the eighth week of fetal life. If it persists the individual possessing it is in constant and serious danger. The mortality of a series of cases of obstruction due to Meckel's diverticulum is enormous. A Meckel's diverticulum usually has no mesentery, is from 3 to 10 inches long, and arises from the convex side of the gut. It may hang free or may be attached to the umbilicus by its tip or by a fibrous cord formed by the obliterated tip. In some cases it remains open at the umbilicus (page 308). In other cases a cord runs from the umbilicus to the gut or the tip of the diverticulum or is adherent to another portion of the intestine. The diverticulum may become strangulated, may enter a hernial sac, may ulcerate or perforate like an appendix (W. Sheen, in "Bristol Medico-Chir. Jour.," Dec., 1901, gives an admirable account of "Some Surgical Aspects of Meckel's Diverticulum"; see also article on "Obstruction of the Bowels by Meckel's Diverticulum," by James E. Moore, in "Journals of Am. Med. Assoc.," Oct. 4, 1902, and on "Abdominal Crises Caused by Meckel's Diverticulum," by Miles F. Porter, in "Jour. of Am. Med. Assoc.," Sept. 23, 1905). Strangulation of the diverticulum may take place beneath an adherent appendix, a Fallopian tube, a portion of mesentery, or the pedicle of an ovarian tumor, or it may take place in an omental or a mesenteric aperture. Gangrene, inflammation, or twisting may occur. Obstruction may be due to invagination of the diverticulum into the bowel. H. Tyrrell Gray collected 39 cases of invagination and added one of his own, 40 in all ("Annals of Surgery," Dec., 1908). Gray shows that

<sup>\*</sup> After Treves, in "Heath's Dictionary."

enteric axis or on the axis of the bowel itself, or two intestinal of twisted together. Volvulus is commonest in the sigmoid flexu occur in a hernial sac.

3. Intussusception is the invagination of a portion of bowel-slumen of an adjacent part of the gut. One-third of all cases of

lumen of an adjacent part of the gut. One-third of all cases of are due to this cause (Treves). Most cases of obstruction in chilto intussusception. Pitt reports that in St. Thomas's Hospital, 1900 inclusive, there were 115 cases of intussusception, and e was under fifty years of age. Gibbon's patient was fifty-eight. Morrison had a case due to polypus, and the patient was six of age. Males are twice as liable as females. During the per peristalsis a localized circular constriction forms and the invagi place through the constricted area. The great relative frequency ception in childhood is due to the greater mobility and irritability bowel (Treves). The irregular and localized spasm is due to bul material within the gut, and according to Rushmore ("Annals August, 1907) the starting-point of invagination is obstruction. talsis alone the cause the condition would be far more common that diarrhea of children. There are four chief varieties: the ileocecal, ileum and the ileocecal valve pass into the cecum and colon; the co the large intestine is prolapsed into itself; the ileal, in which the sn alone is involved; and the ileocolic, in which the ileum prolapses ileocecal valve. Other forms are diverticular (with a diverticulum (due to reversed peristalsis), Meckel's diverticulum, ileo-appendiced The first variety is vastly the most common. In Rushmore's tall of Surgery," August, 1907) the location was definitely stated in 140 of these were ileocecal and 31 were ileocolic.

4. Stricture of the intestine, which may be either cicatricial or o

5. Obstruction by Tumors of the Bowel and by Foreign Bodies may be innocent or malignant. Foreign bodies include, besides stances that have been swallowed, gall-stones and enteroliths calculi. Foreign bodies are apt to lodge in the lower portion of

of mechanical obstruction by a large stone which entered the intestinal canal by ulceration, but that there are three other possible conditions, viz.: Local peritonitis in the gall-bladder region causing paralysis of the bowel; volvulus of the small intestine due to biliary colic or to ulceration of a gall-stone into the gut; obstruction coming on "after the original cause has disappeared" and due to adhesions without or obstruction within the gut.

- 6. Obstruction by tumors, etc., outside the bowel, among the causes of which are retroflexion or retroversion of the womb, especially in pregnancy, cysts or tumors of the kidneys, ovaries, uterus, etc., movable kidney, and enlarged spleen. Obstruction from any of the above causes takes place in the rectum or the sigmoid flexure.
- 7. Obstruction from jecal accumulation is due to paresis or paralysis of the bowel and the diminution or abolition of peristalsis. Obstruction may follow an abdominal operation. Paresis or paralysis arises in the colon. Treves mentions among the rare forms of obstruction kinking of the bowel, adhesions matting the bowels together or compressing the gut, and shrinking of the mesentery.

In addition to the seven groups previously mentioned, we should consider postoperative intestinal obstruction and obstruction from embolism or thrombosis of the
mesenteric vessels. Obstruction of the mesenteric vessels is liable to occur
when the aorta is atheromatous, and usually causes gangrene of the intestine.

Symptoms of Acute Obstruction.—Severe colic comes on suddenly, the pain varying in intensity, but at no time entirely ceasing. In a suddenly arising intraperitoneal accident, whether it be perforation, acute obstruction, or acute strangulation, there is at first shock, from which the patient usually reacts for a time. In obstruction there is constipation, which soon becomes absolute, not even gas being passed; vomiting is early-first of the contents of the stomach, next of bilious matter, and finally of feces (stercoraceous vomiting); the abdomen becomes distended and tender. After reaction from shock some fever may be noted, but in any unrelieved case collapse soon arises; the temperature becomes subnormal; the face, Hippocratic; the pulse, rapid and feeble. The amount of urine passed is very small. In obstruction of the upper third of the ileum true fecal vomiting cannot occur. If obstruction is high up in the small intestine, tympanites does not occur. The tongue is dry, the mind is clear, and muscular cramp may occur. Intestinal peristalsis above the obstruction may be detected through the abdominal wall. According to Elsberg gangrene occurs in only 13 per cent. of the cases. Tapping is more apt to cause pain than is pressure; in peritonitis pressure is more apt to cause pain than tapping (Battle). In intestinal obstruction (postoperative and primary) there is a leukocytosis of from 15,000 to 30,000 (Bloodgood, in "Johns Hopkins Hospital Reports," vol. vii).

Symptoms of Chronic Obstruction.—At intervals there arise attacks of pain which become gradually more frequent and severe, and are linked with vomiting and constipation, the vomiting not being stercoraceous and the constipation not being absolute. Between the painful seizures the patient complains of constipation alternating with fluid diarrhea, distention of the belly, some abdominal uneasiness, anorexia, and dyspepsia. The attacks recur with increasing frequency and severity, and acute obstruction may arise or the patient may be worn out by pain, vomiting, and want of food.



with great distention of the umbilical region, means obstruction of or the cecum. Distention of the entire abdomen and of the flat with tenesmus, with less violent symptoms, less rapidity of progres diminution of urine than in the above-cited forms, means obstruction in the colon or in the rectum. A test for obstruction in the intestine is an injection by a fountain-syringe: if six quarts can be interested in the colon of the large intestine; if less than four quaintroduced, there is probably obstruction in the large intestine. To fa sound in the rectum is generally useless and is often unsafe, cases the seat of the lesion and the cause of the obstruction can be only by exploratory laparotomy.

The determination of the causative condition is always diffic often impossible. Intussusception is the common cause in childr most cases the child was previously healthy. It begins with viole of pain, but although the patient is pale, there is seldom shock at Between the seizures of pain the patient often appears to be in good with a normal temperature and an almost normal pulse. A saus mass can usually soon be felt somewhere over the large intesting be in the right iliac fossa or in the left iliac fossa, but usually over th the transverse colon. Osler reports that a mass was palpable in 66 c and in over one-third of the cases it was noted the first day. It has as early as three hours after the onset of pain. It may shift its po by hour, and it may disappear after having been obvious. It may only when an anesthetic is given. Rectal examination gives no info early cases or cases involving only the small bowel. In late cases a perhaps be felt in the rectum. Tenesmus exists, and bloody mucu in most cases. The abdomen is rarely distended or tender until case and at this period there may be shock or sepsis. Vomiting occu seldom stercoraceous. In obstruction from bands, internal hernia, is a record of antecedent peritonitis, of a traumatism, of a violent e pelvic pain. The attack is sudden in onset, is fierce in character, ally excited by violent exercise or the taking of food. Vomiting is intractable and it soon becomes stercoraceous; pain is violent; perist

tion is negative; abdominal distention and tenderness are early and pronounced; peristalsis above the volvulus is vigorous; collapse is not so rapid nor so grave as in obstruction from bands and internal hernia. Obstruction by a foreign body may sometimes be inferred from the history of some such body having been swallowed. The obstructing body may occasionally be felt during palpation or may be discovered with the x-rays. Abdominal distress may exist for days or weeks before obstruction occurs. Vomiting is late and is rarely severe, but pain, tenderness, and distention are marked. In obstruction from gallstones there will be a record of one or more attacks of hepatic colic. Pain is early and acute, and vomiting is invariable and usually becomes stercoraceous. In obstruction from fecal accumulation chronic obstruction evolves into acute obstruction, pain and vomiting are late or even absent, and the doughlike mass of feces may be felt by rectal examination or by abdominal palpation, In some cases the fluid elements of the feces pass, but the solid elements agglutinate to the walls of the bowel (the diarrhea of constipation). Obstruction from stricture or from pressure comes on acutely after a prolonged period of disturbance, during which period attack after attack of temporary obstruction, complete or partial, takes place, A history of blood or pus in the stools would indicate tumor of the bowel; a history of blood or pus having been absent would indicate pressure from without. In Junctional obstruction there is no local pain, no tenderness, no tumor, no tendency to collapse, but simply distention and absolute constipation, and possibly non-fecal vomiting occurring in a neurotic or hysterical subject. A phantom tumor due to a local distention of the intestine from limited muscular spasm disappears under ether. Obstruction of the mesenteric vessels causes colicky abdominal pain, but early in the case there is no tenderness, rigidity, or distention. Pain in the loin and back is often complained of (McArthur, in "Annals of Surgery," vol. xxxiii). Moderate vomiting may occur and there may be blood in the vomitus. There is great restlessness, usually collapse, and frequently bloody diarrhea, or, at least, bowel washings may be bloody. Cardiac disease can usually be demonstrated and albuminuria is common. Obstruction may follow an abdominal operation (postoperative obstruction); it may arise a day or so after operation; it may arise in ten or twelve days after operation; it may not arise for weeks or months (Legeve). It may be due to some cause at the seat of operation (adhesion of the bowel to a raw surface, volvulus, catching of the intestine under adhesions, etc.). It may be due to some cause distant from the seat of operation (displacement of intestine, bands, etc.). It may arise from paralysis of a portion of the bowel, which may or may not be due to sepsis.\* It may be due to thrombosis of a mesenteric vessel. The symptoms of postoperative thrombosis of the mesenteric vessels, according to A. E. Maylard, † are as follows: Abdominal pain, perhaps colicky in character, gradual or acute in onset, and, as a rule, constant. Early in the case there is no abdominal tenderness, no distention, and no rigidity. The pulse is rapid, the patient is extremely restless, there may be vomiting, but it is never violent, as in acute obstruction; often there is diarrhea, and sometimes bloody diarrhea. These symptoms become particularly significant if there is cardiac or vascular disease. Obstruction from Meckel's diverticulum is usually acute, but is sometimes chronic, and occurs particu-

<sup>\*</sup>Legeve, Gaz. des Hôp., Nov. 23, 1895. † Brit. Med. Jour., Nov. 16, 1901.

larly in young adults and children. It has been stated that other and visible deformities are usually present, but in a study of 69 cases by A. E. Halstead this was true of but one case, in which harelip existed. In obstruction from Meckel's diverticulum there is often a history of former mild attacks (Halstead). Halstead sums up the symptoms as follows: As the obstruction is high up, the abdomen is the shape of an inverted cone; early in the attack there is often local meteorism, especially under the costal arch of the right side, but there is no distention in the flanks. Early, active peristalsis may be visible. The tenderness is just to the right of the umbilicus, on a level with it or below it. In most cases there is early fecal vomiting.†

Differentiation of Intestinal Obstruction from Other Diseases.—Always examine for a strangulated hernia at every hernial outlet. If obstruction is complicated with an irreducible hernia above the seat of lesion, the hernia will always enlarge and become tender because of accumulation of feces. Functional obstruction may attend peritonitis or may follow the reduction of a hernia. Appendicitis with peritonitis may cause symptoms similar to those of obstruction; but there are fever, a history of pain in the right iliac fossa, and the vomiting is not stercoraceous. Acute pancreatitis produces symptoms so similar to those of intestinal obstruction that a diagnosis cannot always be made. Poisoning by arsenic or by corrosive sublimate should not

be confounded with intestinal obstruction.

Prognosis.—Without surgical interference most cases of acute intestinal obstruction die within ten days—usually within seven days. Death may be due to shock, to exhaustion, to perforation, to peritonitis, or to obstruction of respiration and circulation by tympanites. Recovery occasionally happens by the formation of a fistula externally or into another portion of the bowel. In acute obstruction from foreign bodies the obstructing body occasionally passes. Volvulus and strangulation by bands are almost invariably fatal unless an operation is performed. In intussusception recovery occasionally follows the sloughing away of the prolapsed gut, but stricture almost inevitably results from this rare event. Functional obstruction gives a good prognosis. The prognosis of chronic obstruction depends upon the causative lesion. It does not threaten life immediately to anything like the degree that acute obstruction does.

Treatment.—In any abdominal case in which the diagnosis is uncertain and the patient is shocked give an enema of brandy and hot water, wrap the patient in blankets, surround him with hot-water bottles, and study the development of symptoms and signs. In half an hour, as a rule, reaction will be brought about, and a probable diagnosis may be made (Greig Smith). In acute obstruction it is usually customary to empty the stomach by lavage and to evacuate the rectum by means of copious injections given while the patient is in the knee-chest position. The emptying of the stomach is imperative if stercoraccous vomiting has been going on, for vomiting of a quantity of such material while a patient is under ether may cause death by drowning, the fluid flowing in enormous quantity into the bronchi. In very severe cases a general anesthetic cannot be given and the belly must be opened under cocain. Hutchinson's method of taxis and massage is uncertain, and is as

<sup>\*</sup> Annals of Surgery, April, 1902. † Ibid., April, 1902.

liable to inflict harm as to confer benefit. Some surgeons apply constant compression to the abdomen by means of straps of adhesive plaster. Puncture of the intestine with an aseptic hypodermic needle introduced obliquely to relieve gaseous distention is a decidedly dangerous proceeding. The passage of a small tube from the anus to the sigmoid flexure will empty the colon of gas if no obstruction intervenes. In intussusception it is the custom of some surgeons to give no food by the stomach; administer opium and belladonna to arrest peristalsis, wash out the rectum with copious injections, give an anesthetic, and insufflate hydrogen gas or carbonic-acid gas in order to distend the bowel. Other surgeons treat intussusception by forcing air into the rectum by means of an ordinary bellows, and others inject water by a fountain-syringe, the reservoir being at a height of three feet. D'Arcy Power believes in the value of hydrostatic pressure in intussusception in children. He states that the child should be anesthetized and the large intestine filled gradually with hot saline fluid, the reservoir not being raised more than three feet above the patient. The fluid should be retained for ten minutes. My own feeling is that whereas it may be justifiable to try to reduce by gaseous or hydrostatic pressure during the first twenty-four hours of the attack, early operation except in newborn infants gives a better prognosis and is safer and more certain. Without opening the abdomen it is impossible to know the condition of the intestine. Gangrene may occur early (it has been found in less than four hours after the onset of symptoms), and if gangrene exists air distention or hydrostatic pressure will cause death. Rushmore's reported case shows that there may be "no systemic symptoms to indicate the presence of gangrene" ("Annals of Surgery," August, 1907). Another point against conservative treatment is the common uncertainty as to whether complete reduction has been accomplished. Vomiting may continue for hours after genuine reduction and the bowels may not move for some time. Waiting to be sure reduction was accomplished will probably be responsible for death if reduction was not obtained. After the first twenty-four hours it is never justifiable to use gaseous or hydrostatic pressure because of the great risk that ulcer or gangrene may exist. Pressure cannot be accurately regulated, and if the bowel is much damaged, may lead to rupture. If the case is not seen until after the first day, or if injections have been used and have failed, all surgeons believe that laparotomy should be performed.

Frederick Holme Wiggin has made a study of the reported cases of laparotomy for infantile intussusception, and considers that operation done within the first forty-eight hours will give a mortality of 22.2 per cent.\* (see Operation for Intussusception). In very young infants the mortality of laparotomy is very high and it is a fair question if on them immediate laparotomy should be advised without a trial of conservative methods if the case is seen during the first twelve or twenty-four hours. The mortality of operation is very large on those under eighteen months of age. But even in those under six months of age Wiggin thinks the mortality after operation is not above 22.2 per cent. if operation is done within forty-eight hours, and my personal feeling is that operation should be the method of treatment even in the case of a young baby.

I agree with Rushmore that operation done during the first twelve hours

\*Med. Record, Jan. 18, 1896.

would greatly reduce the mortality, perhaps to the figures he expects would come from such a practice, viz., 12.5 per cent.

In obstruction of the main mesenteric vessels operation is of no avail. In obstruction of branches it may be possible to resect the involved region of bowel, a region which is found to be gangrenous or at least is becoming so.

In obstruction from fecal impaction use large rectal injections and give small repeated doses of salines or of castor oil. If there are signs of inflammation, do not give cathartics, even in small doses, but give opium and belladonna to arrest vomiting and to relax spasm. Impactions in the rectum can be removed by the use of a spoon. In acute intestinal obstruction, if the symptoms grow worse, do not wait, but open the abdomen before collapse comes on and find the cause of the obstruction. If it is a gall-stone or enterolith, try to crush it without opening the intestine; if this fails, push it up a little distance, incise the bowel, remove the stone, and close the incision with Halsted sutures. Pilcher\* reports 40 cases operated upon for gall-stone obstruction with 21 deaths. If there is fecal obstruction, break up the masses by pressure and push the fecal plug down without opening the bowel. If there is intussusception, reduce the prolapse and shorten the mesentery; but if reduction is impossible, perform an anastomosis or a resection and enterorrhaphy, or make an artificial anus. In volvulus untwist and shorten the mesentery; but if this is impossible, treat as an irreducible invagination. In obstruction from adhesions try to separate them and straighten out the bowel, stitching healthy peritoneum over each raw spot to prevent recurrence. Anastomosis may be necessary. In flexion separate the intestines, remove the flexion by a V-shaped incision, and suture the wound in the bowel (Senn). In chronic obstruction it is often advisable to perform an exploratory laparotomy, discover the condition, and determine what is to be done to correct it. Some tumors external to the bowel may be removed. Growths in the bowel-wall may be removed by resection of the involved portion of intestine, or an anastomosis may be performed, or it may be necessary to make an artificial anus. In obstruction from Meckel's diverticulum that structure may be found twisted. the gut near it may be kinked or twisted, or the diverticulum may act as a band, the bowel being caught under it or kinked over it. Intussusception of the gut below it sometimes occurs; so does invagination of the mucous membrane of the diverticulum; so does chronic inflammation and cicatricial narrowing of the diverticulum or gut (Halstead). The diverticulum may be gangrenous, perforated, or cystic.

After opening the abdomen the surgeon must be guided by conditions. The diverticulum should be removed, just as the appendix is removed in appendicitis, and complications relating to the gut must be dealt with.

The mortality after operations for acute intestinal obstruction is very high (from 60 to 75 per cent.). If the diagnosis were made earlier, operations would be done earlier and the mortality would be much less. Nine out of 10 of these cases that I see in hospital work are gravely shocked and practically dying on admission. If a patient with obstruction is very gravely shocked, I usually follow Moynihan's plan, of simply opening the bowel and draining it in its most distended coil without any search being made for the lesion. The object is to drain the poisons from the intestine, poisons which are the active

agents in killing the patient. The abdomen is opened under cocain, the incision being small. A distended coil of intestine is sutured to the peritoneum about the abdominal incision, every care being taken that the stitches do not penetrate the mucous membrane of the gut (Moynihan). A purse-string suture is now inserted so as to enclose an area of the exposed gut; an incision is made into the gut in this enclosed area, and gas and feces flow out. Paul's glass tube is passed into the gut and the purse-string suture is tied. Instead of Paul's tube we may use a rubber tube sutured as is the tube in Kader's gastrostomy Elsberg, in "Annals of Surgery," May, 1908). The obstruction is thus mporarily relieved, and if the patient recovers, the causative lesion may be see bsequently sought for and attacked. If a fecal fistula follows the enterosmy and refuses to close, it may be closed by operation. If Elsberg's plan is followed a persisting fecal fistula will be rare. Francis T. Stewart has devised a method by which the bowel can be drained without any risk of Fection of the peritoneal cavity, a risk which always exists in using Paul's be. Stewart places a clamp at either extremity of the loop of bowel and surrounds it with gauze. One half of a Murphy button is inserted into the empty loop through a small incision. The other half of the button is squeezed in to a rubber tube the diameter of which is somewhat smaller than the flange of the button. The two parts of the button are then clamped, and the clamps



Fig. 520.—Fecal fistula: a, Direction of fecal flow; b, b, belly-wall.



Fig. 521.—Artificial anus, showing spur: a, Spur; b, b, belly-wall; c, direction of fecal flow.

are removed from the loop of bowel. The intestine is sutured to the wound margins and the feces drain into a receptacle on the floor. Fig. 522 shows Stewart's operation. In any cases of intestinal obstruction if gangrene exists the temptation to do immediate resection is strong. I have done it a number of times with a very large mortality. Of late I have been following the plan of Mikulicz and results have been far better. The gangrenous loop is brought outside of the abdomen, it is fixed parallel to the wound and enterostomy is performed above it. If a fecal fistula forms it is subsequently closed by appropriate methods. Postoperative obstruction coming on soon after a surgical operation is often not recognized for a time, and the surgeon will be in doubt as to whether he is dealing with peritonitis or intestinal paresis. When in doubt, washout the stomach with warm salt solution, administer salines in small doses frequently repeated, employ enemata, and give two or three doses of atropin at intervals of two hours. Each dose should be gr. 200. Atropin is given with the idea that it increases peristalsis and contracts blood-vessels. It is probably merely sedative, relaxes spasm, and is useless if strangulation exists. If these measures are not quickly followed by the passage of flatus or feces, open the abdomen; never wait for the advent of stercoraceous vomiting (see Legeve).

Fecal Fistula and Artificial Anus.—A fistula is an abnormal opening in the intestine through which gas or a portion of the feces escape (Fig. 520). If all the intestinal contents escape through the opening, it is called an artificial anus (Fig. 521, Senn). A surgeon may make a fistula deliberately (intentional fistula). A fistula may be the product of disease or injury (accidental fistula). Senn enumerates the following causes of accidental fistula: wounds, injury of the intestine, intestinal ulceration, intestinal strangulation, foreign bodies in the intestinal canal, malignant tumors, actinomycosis, pelvic and abdominal abscess, appendicitis, injury of the bowel during an abdominal operation, the application of ligatures, catching by sutures, and the employment of drainage-tubes.

Treatment.—Many fistulæ close spontaneously. This can be hoped for only if the opening is quite small, if the general health of the patient is good,

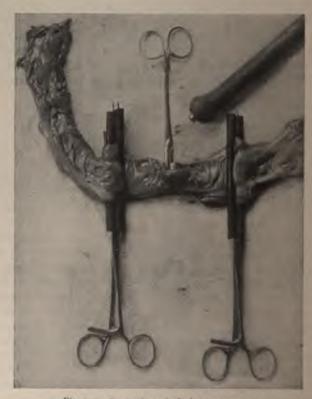


Fig. 522.—Stewart's method of enterostomy.

if the cause has passed away, if the fistula is not lined with mucous membrane, and if there is no spur (spur is shown at a, Fig. 521). In most cases of fistula not high up it is well to give nature a chance to effect a cure, and not to be in a hurry to operate. The part is cleansed frequently with peroxid of hydrogen, the patient is kept recumbent, food is given which does not leave much residue, pads of gauze with pressure are applied, and the bowels are kept regular.

If the track is lined with granulations, it may be touched with lunar caustic; if it is lined with mucous membrane, the actual cautery should be applied; any collection of pus which exists should be drained. If these methods fail, an operation must be performed. The fistula may be sutured by extraperitoneal manipulation (Greig Smith); it may be covered with skin (Dieffenbach); the spur may be removed by means of a clamp; or resection may be performed. In most cases it is best to incise a button of skin around the opening, temporarily suture the fistula, open the peritoneal cavity, deliver the bowel, and suture carefully (Senn's method). In some cases partial exclusion of the fistulous part is necessary, the bowel being divided above the fistula, the end near the fistula sutured, and the other end anastomosed to the bowel below the fistula. In other cases complete exclusion may be performed (page 1107).

Ulcer of the Bowel.—In typhoid fever and in dysentery ulceration occurs. An ulcer may be due to tuberculosis or cancer. An ulcer of the duodenum (see below) is due to the same causes as an ulcer of the stomach. An ulcer of the jejunum sometimes develops after the performance of gastro-jejunostomy for gastric ulcer (page 1075). Curling's ulcer is a chronic ulcer of the duodenum following a burn of the cutaneous surface and due to embolism. An ulcer may heal, and, by causing thickening and constriction, produce chronic intestinal obstruction. It may perforate, causing

collapse and subsequent peritonitis.

Peptic Ulcer of the Duodenum.—Occurs usually in that portion of the duodenum which is above the opening of the bile-duct; in other words, only in the region acted on by the acid fluid from the stomach. In Perry and Shaw's list of 149 cases, the first portion was involved in 123, the second portion in 16, and the third and fourth portions in 2. Reversing the rule in gastric ulceration, duodenal ulceration is more common in males than in females in the proportion of 3 or 4 to 1. It may occur at any period of life, from early youth to extreme old age, but is most common between the tenth and fortieth years. Duodenal ulcers are usually single, but may be multiple, and they are one-twelfth as common as gastric ulcers. A gastric ulcer may exist with a duodenal ulcer. Murphy sums up the supposed causes into hyperchlorhydria, local infection, embolism, and thrombosis, and disturbances of the organs of elimination (for instance, a burn of the skin which may cause Curling's ulcer). An indurated chronic ulcer may exist, and this may heal and produce cicatricial stenosis. An acute ulcer is apt to perforate. Just as chronic gastric ulcer may be latent, no symptoms ever being observed, so may chronic duodenal ulcer be latent. Usually there is pain coming on about three or four hours after taking food, and located in the epigastric or right hypochondriac region. This pain lasts until the next meal and is relieved when the meal is taken, hence we say that food relieves it. If the digestion of the evening meal is delayed the pain rouses the patient from sleep, but a glass of milk will quiet it. Patients usually discover these facts. The pain is less severe than is usual in gastric ulcer and in many cases does not radiate to the back, although in others it does radiate to the right scapular region. Symptoms of indigestion are not nearly so marked as in ulcer of the stomach. Vomiting is far less common than in gastric ulcer and it does not relieve pain. In one-third of the cases there is hematemesis, and sometimes there is blood in the stools. The stools may be,

at times, dark and tarry from blood. The hemorrhage from the bowels may be so profuse as to kill or almost kill the patient. It may be so frequently repeated as to make him profoundly anemic. In many cases there is no visible blood in the feces, but the guaiac or aloin tests show occult blood. Vomiting of quantities of blood is much rarer than in gastric ulcer. Moynihan\* mentions the following complications: severe hemorrhage; perforation; periduodenitis; cancer; and cicatricial contraction involving the bile-duct.

Perforating ulcer is more common than we once thought. Perforation is usually on the anterior wall. It is much less common on the posterior wall. It is extremely rare on the superior wall and practically never occurs on the inferior wall. Moynihan gathered 49 cases from literature and added 2 of his own. In the great majority of cases perforation of the duodenum cannot be differentiated from perforation of the stomach by a study of the symptoms. In some cases the symptoms resemble appendicitis. In most cases there is a sudden onset of violent abdominal pain, followed by vomiting, shock, rapid pulse, and tenderness of the epigastric or right hypochondriac region. As a rule, after a few hours the patient reacts from shock. Sheild's case got better in four hours and walked some distance to the hospital. † Lucy's case got better a short time after the onset, walked home, and attended to a horse, but then became rapidly worse. The improvement is apparent, not real, and is only temporary. The symptoms quickly become worse, and when they become worse, besides the pain and tenderness and rapid pulse, there will be occasional vomiting, rigidity of the abdomen, usually an elevated or normal temperature, and possibly diminution of the area of liver-dulness.

Treatment.—In duodenal ulcer the risks of serious hemorrhage and of perforation are much greater than in gastric ulcer, and operation should always be recommended if the diagnosis is made. We used to say operate only if the symptoms are not amended by rigid diet and medication; if severe hemorrhage occurs or if cicatricial contraction interferes with the passage of food through the bowel or bile into the duodenum. Moynihan refers to four cases of chronic ulcer operated upon and all recovered. In some cases excision is practised, in others excision with gastro-enterostomy or gastro-enterostomy

If grave hemorrhage occurs and is repeated the surgeon should open the abdomen, ligate the bleeding vessels, bring the outer coats of the bowel together over the indurated area, and perform posterior gastrojejunostomy (Wm. J. Mayo, in "Surg., Gynec., and Obstet.," May, 1908). In such a bleeding ulcer the vessels entering it are usually varicose.

In perforation operation is performed, as in gastric ulcer, as soon as possible. In these cases, as in perforated gastric ulcer, I believe operation should be immediate and that we should not wait for a possible reaction from shock. The ulcer is inverted by two rows of silk sutures. Some surgeons do not drain, but I would feel it safer to drain. B. G. A. Moynihan† gathered 49 operations for perforated ulcer with 8 recoveries. Mr. T. Crisp English reports 8 operations for perforation of duodenal ulcers, with 2 recoveries ("Lancet." Nov. 28, 1903). In perforated duodenal ulcer the extravasated

<sup>\*</sup>Lancet, Dec. 14, 1901. † Ibid., March 29, 1902. ‡ Ibid., Dec. 14, 1901.

fluid is apt to flow into the right iliac region. If an erroneous diagnosis of appendicitis was made, on opening in the right iliac region, by giving vent to this fluid, might for a time confirm the surgeon in error, but the character of the fluid should make evident the condition of affairs.

Ulcer of the Jejunum after Gastro-enterostomy.—(See page 1075.) Perforated Typhoid Ulcer.—Perforation occurs in 2 or possibly 3 cases out of 100. About 70 per cent. of perforations occur in the second, third, or fourth week. Perforation in a typhoid ulcer is usually effected rapidly, a large opening is formed, and a considerable quantity of fecal matter is passed into the peritoneal cavity. In some perforations very little fluid escapes. Severe pain and a nervous chill indicate that perforation is occurring or has occurred. Some maintain that the two above-named symptoms associated with marked leukocytosis indicate that perforation is about to occur, and they call this stage the preperforative stage. That distinct symptoms may in some cases point to impending perforation is, I believe, true, and in one case I operated on the conviction and found two areas almost perforated. In most cases, however, I do not believe that there is a distinct preperforative stage, but the perforation exists when the symptoms are first noted. The conviction that perforation was occurring would be strengthened by a progressive increase in the leukocyte count. It is to be remembered, however, that the leukocyte count is increased by sweating, cold bathing, vomiting, hemorrhage, severe diarrhea, or some positive complication. When perforation occurs, violent pain develops. As a rule, there are tenderness, rapid pulse, costal respiration, abdominal rigidity, vomiting, and shock. Usually there is temporary reaction from shock, the subnormal temperature giving way to a normal or to an elevated temperature. The vomiting in some cases becomes stercoraceous. There is constipation and sometimes dulness on percussing the flanks. The face is Hippocratic. The patient may die of the preliminary shock or may react and die subsequently of blood-poisoning. In a few hours after perforation distinct leukocytosis may be observed, but it may never take place at all. Even when leukocytosis arises, it may disappear as peritoneal infection spreads and systemic poisoning deepens. Le Conte points out that rupture of the mesenteric glands simulates intestinal perforation.

Treatment.—Leyden suggested operation in 1884 and in the same year Mikulicz did the first successful operation. Before Mikulicz's paper was published my colleague, Dr. James C. Wilson, published a paper in which he advocated operation. Death is practically certain without operation. Operation should save at least one-fifth of the cases. Operation should be done at once, proper means being adopted to combat shock. In many cases a general anesthetic should not be given, but a local anesthetic should be employed. The incision should be made in the right iliac region and the colon should be first located and then the end of the ileum. By locating the colon we obtain a fixed point from which to begin our search for perforations, and by opening the abdomen in the right iliac region we come down at once onto the perforated gut in the vast majority of cases. When a perforation is found, it should be inverted with two layers of Halsted sutures. It is not wise to excise the ulcer. If the bowel is very badly damaged, resection can be considered, but it is usually wiser to make a temporary artificial anus. After finding a perforation and closing it, examine to see if there are others.

Close every perforation, and if a point is found who bowel-wall indicates that perforation is liable to occu inverting the area of ulceration by sutures. Clean th ing with hot salt solution. Leave the wound open, in: gauze, and establish tubular suprapubic drainage. Ele in bed and employ continuous proctoclysis of salt solu ten times for typhoid perforation with three recover of shock. In one case the perforation was not four postmortem in the hepatic flexure of the colon, the ga sible for the ulcer of the bowel. One case improved days, developed another perforation, and died of showed that the sutured perforation was soundly close man, brought to me by Dr. Godfrey, was operated after perforation. There was one perforation near the fecal extravasation. The opening was large and st The several inches of bowel between the ulcer and t sented several ulcers almost perforated. The patier resection. After cleansing the abdomen an artificial a to the perforation. The patient recovered and subs successfully abolished by a resection. In another case, on opening the abdomen a violent appendicitis was for swathed in lymph and gangrenous. The appendix showed a perforation in a loop of gut two feet from the was considerable extravasation. The perforation was eum was cleansed, drainage was inserted, and the p tures from the appendix and from the peritoneal cavity bacillus. In a third case, that of a young woman, imp diagnosticated by Dr. Kalteyer because of pain, tender definite and increasing leukocytosis. Two ulcers perforated were found. They were covered over b sutures, the wound was closed without drainage, Culture from the peritoneal cavity was negative. cases were operated upon in the Jefferson College H

Primary Intestinal Tuberculosis.—According 80 cases on record. He reported 29 cases to the S in 1892. Primary tuberculosis is very rare, whereas is common. The exact propriety of rigidly regarding is doubtful. Kocher's cases came from tuberculous infancy from enlarged glands, pleurisy, or bronchitis, that, in all probability, there had for some time been a latent tuberculous focus, and from this focus can attacked the intestine. Intestinal tuberculosis, in t begins with the formation of multiple ulcers, due to sputum. Primary intestinal tuberculosis usually b several, or even many ulcers in the ileum or perhaps ulcers tend to heal and form strictures. Occasionally, there is enormous tumor-like thickening of the cecum tuberculosis, the conglomerate tuberculosis of Mayo. rule, are slight, attacks of pain occurring now and th ually developing. The urine shows the diazo reactio Treatment.—In the first stage the proper treatment is excision of ulcerated areas, possibly excision of the cecum. Later, if stricture is causing chronic obstruction, an operation may be performed to give relief. Laparotomy, careful separation of adhesions which are not fused with the gut, and the

introduction of iodoform may prove of value.

Malignant Tumor of the Intestine.—Sarcoma is very rare, but does sometimes arise, particularly in young persons, and it enlarges very rapidly. It is most prone to attack the large intestine. Jopson and White \* report 1 case and also collect 22 others. The mesenteric glands frequently enlarge. Cancer is not uncommon, attacking especially the middle aged. According to Rolleston, the average age in duodenal cancer is fifty-two years, in jejunal and iliac cancer forty-seven, in cancer of the cecum nearly forty-eight, and in cancer of the rest of the large intestines about forty-nine years. It is most common in the neighborhood of the ileocecal valve and in the sigmoid flexure. Ewald collected 1148 cases of cancer of the intestine. In 64 cases the cecum was involved; in 24 cases the ileum was involved. It produces pain at the seat of growth, and after a time constipation, or constipation alternating with diarrhea, and finally intestinal obstruction. In some cases the symptoms appear suddenly, acute obstruction taking place or intussusception occurring. It is usually possible to palpate the tumor, which is hard and immovable. The patient wastes rapidly and is apt occasionally to pass blood at stool. The growth does not enlarge very rapidly and glands are not involved early. In some cases the supraclavicular glands enlarge. In more than one-half of the cases which die of intestinal cancer there is no lymphatic infection. †

Treatment.—Early in the case exploratory laparotomy should be performed, followed, if possible, by excision with end-to-end or side-to-side approximation. This is done for either cancer or sarcoma. It may be possible to remove enlarged glands. In cancer of the cecum extirpate the cecum and implant the end of the ileum into the side of the colon (Wm. J. Mayo). If excision is impossible, the growth should be side-tracked by performing lateral anastomosis. In advanced cancer of the large bowel, if resection is impossible, make an artificial anus above the tumor (cancer of rectum, page 1182).

Appendicitis.—Appendicitis, which is an inflammation of the vermiform appendix of the cecum, is almost invariably the primary lesion of all of those various conditions known as typhlitis, perityphlitis, paratyphlitis, etc.—terms which seldom imply pathological entities, and are in most instances well relegated to obscurity. I say in most instances, not in all, because I believe there is such a condition as primary inflammation of the cecum, although it is extremely rare. This rare condition may cause perforation, perityphlitic abscess, or peritonitis when the appendix is sound. It is not to be distinguished clinically from appendicitis (McWilliams, in "Annals of Surgery," June, 1907). Involvement of the cecum as a result of appendicitis is common. It was recognized by some observers many years ago that such a disease as inflammation of the appendix existed, but the majority of the profession did not grasp the fact. In 1750 Mestevier, of France, reported a case of perforative appendicitis with peritonitis.‡ In 1812 a perforated appendix was shown

<sup>\*</sup>Am. Jour. Med. Sciences, Dec., 1901. †Wm. J. Mayo, Jour. Am. Med. Assoc., Oct. 19, 1901. ‡Jour. Méd. et Chir., 1760.

to the Medico-Chirurgical Society of London, and in 1835 Southam reported an appendiceal abscess (Manley). In 1848 Hancock reported an appendiceal abscess ("Lancet," 1848, p. 380). It is interesting to note that this was a case of appendicitis in pregnancy. Ten days after a premature delivery an abscess was opened. About two weeks after operation two fecal concretions came out of the wound. In 1827 Dr. L. Méllier described appendicitis, and named among its symptoms fixed pain in the right iliac fossa and colic. This brilliant and original man was years ahead of his contemporaries. He reported cases of undoubted appendicitis verified by autopsy, described gangrene, perforation, associated peritonitis, and appendiceal concretions. His original article, Manley tells us, is in the "Journal of Medicine, Surgery, and Pharmacy" for 1827, second series, 110.\* Mellier said: "If it were possible to establish with certainty the diagnosis of this affection, we could see the possibility of curing the patient by operation. We shall perhaps some day arrive at this result."† In spite of Méllier's writing's, the profession adhered for half a century to the view of Dupuytren, put forth in 1833, that abscesses in the iliac region take origin from the cecum and not from the appendix. Dr. Reginald Fitz, of Boston, in 1886 persuaded the world that the appendix is the real seat of most inflammations in the right iliac fossa. This structure is particularly liable to infection because of the large amount of lymphoid tissue in its make-up, because it is in a dependent position, is always full of bacteria, has a poor blood supply, and is readily blocked by kinking or by swelling of its mucous membrane. Further, as a vestigial structure, it has a low resisting power. The appendix is a long and narrow diverticulum (musculomembranous in structure), which comes from the posterior and internal part of the head of the colon, and which probably has no physiological function (in herbivora and rodents it is a functionally active organ). The structure of the appendix is similar to the structure of the colon, except that the muscular structure is ill developed and trivial in amount. Lockwood points out that there is an extensive lymph system in the appendix, and that the submucous and subperitoneal tissues communicate by numerous gaps in the muscles.‡ This structure has a poor blood-supply, and in consequence gangrene occurs from rather trivial causes. It is supplied by a branch from the superior mesenteric artery. In women there is sometimes an additional supply by a vessel running in the appendiculo-ovarian ligament. The nerves are derived from the superior mesenteric plexus. The appendix averages about four and a half inches in length, but varies in size between the limits of one-third of an inch and a little over 9 inches. In 641 autopsies the longest appendix was 93 inches and the shortest was one-third of an inch (Monks and Blake). Its diameter is, as a rule, about equal to that of a No. o English bougie; its canal is narrow and is partly closed by the valve of Gerlach (Talamon). The appendix enters the cecum at its posterior internal part, which is usually the seat of the most intense pain in inflammation, and corresponds to a point on the surface two inches from the anterior superior spine of the ilium, on a line drawn from the umbilicus to the iliac spine. which is known as "McBurney's point." The free part of the appendix

<sup>\*</sup>Thomas H. Manley, Med. Record, July 19, 1902. †See R. J. Lee Morrill's article in the Amer. Med.-Surg. Bull., Dec. 19, 1896. †Brit. Med. Jour., Jan. 27, 1900.

in one-third of all persons is in relation with the posterior surface of the cecum; in almost one-third of all persons it is fixed in the iliac fossa, so that if perforation occurs, the contents will be voided in the retroperitoneal tissue (iliac abscess). In some cases it is external to the cecum; in some it passes downward, and in some inward. It is important to remember that the appendix may be met with in the most unexpected situations. When the ascending colon is displaced, the diverticulum may be upon the left side. It is not unusual to find its tip in the middle line, up toward or adherent to the gallbladder, or in the pelvis. In about two-thirds of all cases the appendix is completely covered with peritoneum; in one-third of all cases it is in contact, in some part of its length, with cellular tissue (Talamon). Byron Robinson has called attention to the fact that the appendix is frequently in contact with the psoas muscle in men, and may be bruised by this muscle. In 10,000 autopsies the appendix is said to have been absent five times. In most cases where surgeons have been unable to find the appendix it was not absent, but was covered with peritoneum. Occasionally the appendix is found in a hernial sac.

Etiology and Pathology.—Appendicitis is very rare in infants. operated unsuccessfully on a male two years of age for gangrenous appendicitis. Savage operated unsuccessfully on a baby sixty-one days, and Weiss operated unsuccessfully on a child twenty months old.\* I. P. Crozer Griffith † has collected 15 cases in children under two years of age. One of these patients was three months of age. Nine of the 15 were operated upon, with 7 recoveries. In 4 of the cases the appendix was in the scrotum. In 2 cases a diagnosis of intussusception was made. In children of nine or ten years of age the disease is by no means infrequent. Appendicitis is common at any period beyond childhood, being more frequent in young and middle-aged people than in the aged. It is about four times as common in males as in females. It is more common in summer than in other seasons, and in warm countries than in cold or temperate climes. Appendicitis is a bacterial disease. It is produced occasionally by pus cocci, but most commonly by the action of the bacterium coli commune of Escherich. The colon bacilli, which normally inhabit the appendix, are harmless when the appendix is healthy, but become active for harm when the diverticulum is bruised, obstructed, irritated by the presence of uric acid, congested because of chilling of the cutaneous surface of the body, or distended by the ingress of colonic fluid (C. Van Zwulenburg in "Annals of Surgery," March, 1905). It seems probable that flatulent distention of the colon may be responsible for forcing fecal matter in quantity into the appendix and may lead to plugging of the opening (Rubin, in "Jour. Am. Med. Assoc.," vol. xliii, No. 18). When non-traumatic inflammation occurs, swelling of the mucous membrane occludes the opening into the colon, and the lumen of the appendix dilates and fills up and becomes distended with a thick mucopurulent fluid. Ulcers sometimes form, which may only involve the mucous membrane, may pass deeply into the coats, or may even perforate. Dieulafoy I maintains forcefully that appendicitis is due always to the conversion of the appendix into a closed cavity, but cases are met with which disprove this assertion. Various conditions may bring about this transformation.

1 Progrès médicale, No. 11, 1896.

<sup>\*</sup> Manley, in Med. Record, July 9, 1902. † University of Penna. Med. Bull., Oct., 1902.

Partial obstruction may be caused by calculi, which ar material and hordes of bacteria mixed with salts of lime calculi are not formed in the colon but are formed theory that concretions form in the colon and are force peristalsis has been very largely abandoned. Dieula dition as appendicular lithiasis, and says it has a ter lines, and has a kinship with gout and rheumatism. caused by local infection of a catarrhal area, by the stricture, or by several causes acting in unison. The tion is always dangerous. It is frequently associated as cause or effect. It is a mass of virulent bacteria. ation or gangrene. Talamon taught that the append of the concretion, reflex contraction of the muscular o is accompanied by violent pain (appendicular colic). ture is so rudimentary that it does not seem probable traction, even should they arise, would produce via symptoms. Pozzi believes that appendicular colic ma or bending of the appendix or malposition of the d that pain may arise when there is no lesion in the ar mation of the peritoneum or pericecal structures.\* dicular colic is really inflammation of the appendix the peritoneum. The term appendicular colic has le conservatism, and, as Lockwood shows, if an append individual who suffers from attacks of appendicular found that the diverticulum is inflamed or the lumer Foreign bodies, such as pins, fish-bones, nails, butto stones, and grape-seeds may enter the appendix, but than is generally supposed, most alleged grape-seeds fi fecal concretions. Fitz found concretions in 15 case collected the records of 459 postmortems, and found cretions and 16 foreign bodies. Appendicitis due to a grape-seed or a pin, is known as traumatic; appendicit is the assumed cause is known as stercoral. A fore instant perforation. If impaction of a foreign body o orifice of the appendix is closed, the circulation is soo are retained, the coats become congested, the diver mously, microbes multiply with great rapidity, and th appendix inflames and may become gangrenous or ulce forated. Interference with the blood-supply of the a to appendicitis. This may be brought about by tw concretions, pressure, or bands; and the psoas muscle production of these conditions. In women appendici dary to tubo-ovarian disease. Appendicitis is rarer probably because in many females the appendix has a in males, the additional supply coming through the f ovarian ligament. In women disease of the uterus or cedes or actually causes appendicitis. Catarrhal cor habitual constipation, and indigestion with flatulence

<sup>\*</sup> Progrès médicale, No. 19, 1896.

dicitis. In fact, in a great many cases there has been a more or less prolonged history of diarrhea or constipation and flatulent indigestion before the development of acute appendicitis. An acute attack of appendicitis may arise after the eating of a large and indigestible meal, especially if such a meal was taken late at night. Bolting the food and eating large meals at irregular hours predispose to an attack. It seems probable that catarrhal appendicitis may result from extension of a catarrh of the colon, and may also in rare cases arise from external traumatism. In most cases, however, in which appendicitis seems to be produced by a blow, the injury simply "awakened a sleeping dog" and stirred into acute inflammation an appendix already diseased. If before perforation the appendix adheres to the cellular tissue behind the cecum, cellulitis or abscess without peritonitis may result. When appendicitis goes on to perforation, there is always some peritonitis; but if the steps to perforation are gradual, and if the causative organism is the colon bacillus, the peritonitis may be local, and will sometimes, by formation of adhesions, make a barrier between the appendix and the peritoneal cavity before operation occurs. When perforation takes place suddenly, diffused septic peritonitis is inevitable. When the causative organism is the streptococcus, general peritonitis is very apt to arise. Peritonitis may arise without perforation by contiguity of structure or by migration of bacteria through the congested walls of an obstructed appendix. In some cases perforation takes place into the peritoneal cavity, but pus is circumscribed by matting together of the intestines with plastic exudate. The appendix may become gangrenous very rapidly or after some time. A case of appendicitis in which gangrene and perforation come on very quickly is spoken of as fulminating appendicitis. In some cases, if the perforation is very small and the appendix is swathed in lymph, or if perforation does not occur, the inflammation may subside. Perforation rarely occurs from liquid pressure or from the pressure of a concretion; it is generally due to ulceration produced by the action of micro-organisms. Appendicitis which subsides may at any time recur, and the life of such a patient is under constant menace. An enormous number of people have had appendicitis. Toft recorded 500 autopsies, and in 36 per cent. of them there were positive signs of past attacks. The disease is occasionally unsuspected during life. These facts prove that the disease may subside without the aid of surgery.

Forms of Appendicitis.—In what is known as appendicular colic the appendix is temporarily obstructed because of transitory inflammatory swelling of the mucous membrane of the outlet, and the stercoral contents are retained in the diverticulum. The peritoneal covering is continuously in the inflammation. This condition is called by Fergusson "constipation of the appendix." If not relieved, it will eventuate in appendicitis with involvement of the peritoneum. It is an unfortunate term, sometimes used as an excuse for avoiding operation. In such cases a concretion is frequently or usually present.

Simple parietal or catarrhal appendicitis is not limited to the mucous membrane; hence the term catarrhal is not strictly correct. The vessels of the appendix are distended with blood, the lumen at the intestinal end becomes partially or completely obstructed, the epithelium desquamates from numerous glands, the mucosa ulcerates, and the lumen of the appendix becomes filled with a mixture of mucus, bacteria, and portions of organic matter. Bacteria enter the lymph-spaces of the wall of the appendix, and pass rapidly from the

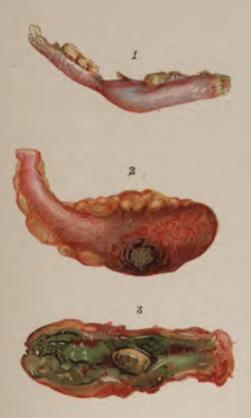
nesh attack at any time. In a catarrhai hinahination secondar the colon the case may be chronic from the beginning. If the appendix is gradually and completely obliterated, the condition is obliterative appendicitis (Senn). This progressive obliteration from repeated attacks of inflammation, or may be simply a degener Recurrent appendicitis, it was once said, may be due to inordina mouth of the appendix, making of this diverticulum a drag-ne bodies; but we now know that it is more probably due to sma opening, so that it quickly closes from slight swelling and conver dix into a closed vase filled with septic material. Suppurative is due to purulent infiltration of the walls. Pus in the lumen is appendicitis. Pus may form about the appendix, a condition kno diceal or appendicular abscess. Gangrenous appendicitis is a m gangrene, due to interference with the circulation and to tissue-d the action of micro-organisms. Perforations occur, and they are ple. The entire appendix may slough off. Interference with cir be caused by an obstruction, by a bend or twist or bruise of the ap the action of virulent organisms on an appendix whose tissue-resis ered by injury or disease. In gangrenous cases the vessels of the dix are usually obstructed by thrombi or the changes of arteritis In rare instances appendicitis is due to tuberculous ulceration, in typhoid ulceration, and genuine appendicitis may arise during t

Fowler suggests the following classification of cases of appeando-appendicitis; (2) parietal appendicitis; (3) peri-appendicit

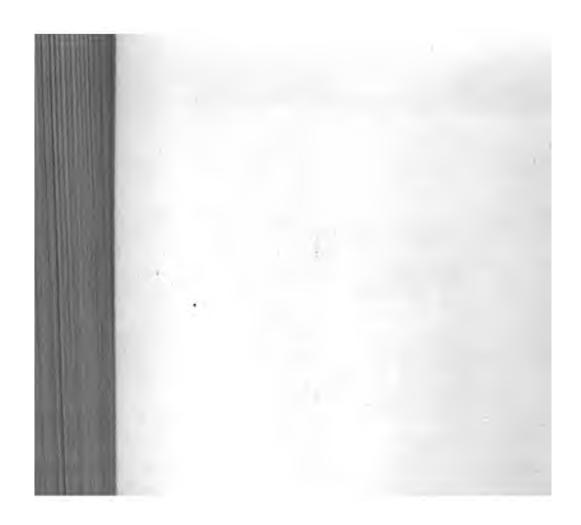
appendicitis.

As a matter of fact, appendicitis is always one disease, which vasity, and it is useless to divide it into a great number of sympton

Symptoms and Signs.—In what is known as appendicular tient suffers from disorder of digestion and occasionally has a bi abdominal pain associated with trivial and temporary tenderness iliac fossa. The colicky pain is about the umbilicus and right iliac is often nausea and usually constipation. This condition, if not s is followed by the evidences of peritoneal inflammation. The



Various forms of appendicitis (from drawings by Dr. M. H. Richardson): 1. Obstruction from stenosis of appendix. 2. Dilatation of distal end of appendix; perforation by a fecal concretion. 5 Gangrene of nearly the whole of the appendix; fecal concretion in lumen.



monitory symptoms have lasted a variable time, and the acute symptoms very frequently appear in the early hours of the morning. The first definite symptom is severe colicky pain. The tongue is coated and usually dry. Great thirst is often complained of. The face is expressive of pain, or later, in a severe case, becomes Hippocratic. The posture assumed for greater ease is one of recumbency with the right thigh and knee or both thighs and knees partly flexed. Respirations in acute appendicitis are shallow and thoracic. The development of acute pain is usually the most prominent symptom. The pain is at first colicky and located about the umbilicus or through the abdomen in general, this distant, primary, or generalized pain, according to Treves, corresponding to the distribution of the superior mesenteric plexus. This primary pain may subside if the appendix succeeds in emptying its contents into the colon, but it may also subside if the appendix becomes gangrenous or ruptures (Murphy). Usually, in from twelve to thirty-six hours the pain becomes localized in the right iliac fossa, and associated with tenderness and hyperesthesia of the skin-in other words, true inflammatory pain develops. It is due to peritoneal inflammation. The usual location of the pain in the right iliac fossa depends on the fact that the appendix is usually placed in that region. Occasionally, when the appendix crosses the belly, the pain is located on the left side, and occasionally, for like reasons, in the gall-bladder region, the right loin, or the pelvis. If the pain of appendicitis is violent, the patient presents some evidences of shock. Nausea is the rule in appendicitis; vomiting usually occurs early-about three or four hours after the beginning of pain. In children vomiting is often violent and persistent, but in adults, after the early hours of the attack, vomiting occurs, as a rule, occasionally or not at all, although nausea is complained of. Early vomiting is a reflex symptom due to distention of the appendix (Murphy). If vomiting persists, it points to peritonitis, to pus-formation, or to intestinal obstruction unless it results from the administration of morphin. There is usually constipation in acute appendicitis, although diarrhea occasionally occurs. In appendicitis there is always some elevation of temperature, although it may be very slight and of brief duration. The fever is not ushered in by a chill, but the temperature mounts in the course of a few hours to 102° or 103° F. or even higher. The fever does not begin until several hours or a number of hours after the onset of pain. In a very mild case the temperature remains elevated for a day or two and then falls to normal. In severe cases it is apt to remain elevated for a longer period, but it is always to be borne in mind that in very grave appendicitis the surgeon may find very little elevation of temperature, no elevation, or actually a subnormal temperature. In gangrenous cases, and in cases in which a large perforation suddenly forms, and when general peritonitis develops, there is usually, for a time at least, a subnormal temperature. A sudden drop of temperature indicates, as a rule, a calamity, particularly gangrene of the mucosa of the appendix, which prevents absorption (Murphy) or perforation of the appendix. Leukocytosis is usually present (see Diagnosis). The pulse in appendicitis is in most cases rapid. A very rapid pulse (over 110) is significant, usually, of a severe case, and the auguries are especially ominous if the pulse is rapid but the temperature is normal or subnormal. Occasionally, however, a slow pulse exists, even in the worst cases.

Examination of the abdomen discovers, early in the case, general abdominal rigidity; but usually in the course of twenty-four hours or more the general rigidity passes away, the abdomen distends more or less, and rigidity of the lower half of the right belly becomes evident and persists. If general peritonitis begins early, general abdominal rigidity does not abate or pass away. If general peritonitis begins later, general abdominal rigidity, which was present at first but which passed away, returns. Rigidity may not exist in the very beginning of appendicitis, in a case in which the appendix is retrocecal or pelvic, in some abscess cases, or in a case with relaxed belly walls.

A symptom almost invariably present in appendicitis is tenderness. In some cases the tenderness is diffuse; in most it is localized, or at least most acute, in the right iliac fossa. The point where tenderness is usually most acute is a spot about 2 inches internal to the anterior superior spine of the ilium. on a line drawn from that bony point to the umbilicus. This is known as "McBurney's point," and overlies the usual point of origin of the appendix. In some cases, however, the greatest point of tenderness is nearer the gallbladder; in others in the loin; in others toward the umbilicus, in the mid-line. or on the opposite side; in others in the rectum. The seat of greatest tenderness depends on the situation of the appendix, and it is usually at McBurney's point, because this usually overlies the origin of the appendix. The lesson is that in appendicitis there is a point of tenderness or of greatest tenderness in a region which the appendix could occupy. If tenderness exists on the right side and then develops in the left side, severe spreading peritonitis usually exists (W. Meyer). When the appendix becomes gangrenous, local tenderness may for a time disappear, because the peritoneum of the involved region has become anesthetic; later, however, it returns, spreads, and may become general. In view of the fact that tenderness in the right iliac fossa is often demonstrable in tubal and ovarian disease, the sign in males "is of greater significance than in females" (A. H. Tubby, on "Appendicitis," Medical Monograph Series). Pressure upon the left side will, in some cases, cause pain in the right iliac region. When rigidity abates or disappears, the case may go on to cure, but sometimes a mass becomes evident in the right iliac fossa. The mass, of variable shape, is at first hard, and if of any considerable size, is dull on percussion. In some cases, when no mass is palpable through the abdominal wall, rectal examination detects one. This mass may be agglutinated bowel and omentum or a collection of coagulated inflammatory exudate. It may gradually disappear or an abscess may form. The evidences of general peritonitis are: great distention because of intestinal paresis. general abdominal tenderness, rectal tenderness, very rapid pulse, hiccough, persistent vomiting which may become regurgitation, and, as Meyer points out. percussion dulness over the right iliac region or entire lower abdomen.

In some cases the symptoms, at first trivial, become grave. In some all the symptoms are violent from the beginning, the attack tends to linger, and is followed by persistent soreness of the appendix and harassing digestive disturbances. Any case of appendicitis may become suddenly desperately grave because of perforation or gangrene, and in any case general peritoritis may develop. After sudden perforation or rapid gangrene the temperature falls, hiccough begins, abdominal distention, pain, and tenderness become marked and general, and the pulse becomes very rapid. In some cases

these grave symptoms are present almost from the start (fulminating cases). A sudden perforation produces collapse, and, if reaction takes place, general peritonitis arises. Peritonitis, be it remembered, may arise without either perforation or gangrene. If pus forms, it may be unlimited by adhesion. In such cases there is the rapid onset of fatal peritonitis and septicemia. Pus may be limited by adhesions and be practically extraperitoneal. In such a case a lump is felt in the right iliac region, but dusky discoloration and edema of skin very seldom exist. The surgeon does not wait for fluctuation before he makes a diagnosis. In an abscess case there are usually irregular fever and sweating, but rigors do not occur. Hawkins says we should always suspect pus if the symptoms continue after the sixth day, and particularly when the symptoms abate and suddenly increase between the seventh and tenth days. A limited collection of pus may be liberated into the peritoneal cavity by rupture of the abscess-wall. Such a rupture may be caused by pressure or muscular effort; rupture is followed at once by shock and later by diffused peritonitis. An abscess may rupture externally or into the vagina, intestinal tract, or bladder. It is desirable, if possible, to locate the situation of the appendix, and this is usually determined by locating the seat of swelling and of greatest tenderness. The surgeon should not lose sight of the fact that the appendix may be found in the most unexpected situations. In every case a rectal or vaginal examination should be made, in order to detect swelling and tenderness, and thus determine if the inflammation took origin in or has come to involve the pelvic region. Pain at the end of micturition points to involvement of the vesical peritoneum.\* In cases where there is not localized swelling and is not local tenderness,-for instance, in gangrenous or perforative appendicitis with general peritonitis, - "diagnostic localization" is impossible (Van Hook).

Terminations and Prognosis.—Acute appendicitis may terminate in death, in complete recovery, or in a condition of lowered vitality during the existence of which acute attacks are almost certain to occur. Sometimes after and sometimes without an antecedent acute attack the patient develops persistent soreness and tenderness in the right iliac region. Between the attacks of recurrent appendicitis there may be soreness, tenderness, and gastro-intestinal disturbance, or there may be no evident trouble whatever; yet, even in the latter case, there may be an ulcer or ulcers of the mucous lining. If a patient has once had appendicitis, he will always be liable to suffer from another attack if the appendix has not been removed. The liability becomes almost a certainty if the intestinal end of the appendix is narrowed or if the lumen is obstructed at any point, if a concretion exists, or if there is an area of ulceration or of desquamating epithelium. After an attack the appendix may remain enlarged and tender; exercise or indiscretion in diet may cause it to become tender or the patient may have occasional attacks of colicky pain. If any of the above conditions exist, another attack may be confidently anticipated if operation is not performed. In such cases the appendix can usually be palpated. The method of palpation proposed by Robert T. Morris is very useful.† It is applied as follows:

<sup>\*</sup>Van Hook, in Jour. Am. Med. Assoc., Feb. 20, 1897. †See Medical Record, Sept. 17, 1898.

The surgeon stands to the right of the patient and uses three fingers of the right hand to feel with and three fingers of the left hand to press with. Morris insists that no muscular effort should be used by the hand which feels. The feeling fingers are pressed by the other fingers beneath the margin of the right rectus muscle on a level with the umbilicus, and are drawn toward the patient's right side, and the colon will be felt to roll under the fingers. The process is repeated several times until the end of the cecum is reached. The appendix is sought for by rolling the cecum from side to side with the finger-tips, and working toward the proximal end of the appendix.\*

Adhesions may form as a result of appendicitis, general peritonitis may arise, the appendix may slough or become perforated, or abscess may ensue upon local peritonitis. Lymphangitis of the appendix may accompany, and septic lymphangitis or phlebitis and secondary hepatic and lymphatic infections may follow, appendicitis. They are thought to be most common after mild attacks of appendicitis. The secondary lymphatic and hepatic infections are of the greatest importance. There may be abscess of the liver, subphrenic abscess, or retroperitoneal lymphangitis.

A subphrenic abscess may result from infection carried from the appendix by the lymphatics, from pus ascending along the posterior cellular spaces, or by direct invasion from the peritoneal cavity (John C. Munro, in "Annals of Surg.," Nov., 1905); such an abscess is usually on the right side but may

be upon the left.

Lymphangitis is the rule in appendicitis, and when we open the abdomen, there is usually evidence of it in the lymph-glands of the mesentery, and in children particularly these glands are apt to be enlarged. One lymph path from the appendix is through the ileocecal glands, another is posterior to the cecum and retroperitoneal, and the latter reaches the liver and diaphragm (Munro). In lymphatic infection an abscess may form anywhere in the course of the lymphatics. Abscess of the liver usually results from portal invasion but may result from lymphatic infection.

Among other possible consequences of appendicitis may be mentioned pyemia, empyema, inflammation of the parotid gland, and thrombosis of the right iliac vein. A positive prognosis of any case of appendicitis is an absolute impossibility. The future of every case is cloudy with uncertainty, and the most that can be attained in the field of prediction is a scientific guess of more or less probability. All surgeons have seen apparently hopeless cases recover, and have observed cases with the most trivial symptoms grow progressively worse or suddenly develop a fatal complication. Further, after one attack other attacks are very apt to arise. The medical man who estimates that 80 or 90 per cent, of cases get well without operation has probably dealt with many catarrhal cases, and he certainly is optimistic as to freedom from future attacks, because, as stated before, recovery from an attack does not of necessity mean freedom from the disease. In appendicitis there may be delusive evidences of improvement; for instance, the abatement of pain and the lessening of fever, being regarded by the patient himself as indubitable signs of improvement, may in reality be indicative of gangrene. In spite of the previously mentioned difficulties and obscurities we can in the majority of cases decide with a reasonable probability of accuracy

<sup>\*</sup>Robert T. Morris, in Medical Record, Sept. 17, 1898.

whether or not the patient is becoming worse. In a delusive improvement some signs and symptoms improve, but all do not; and in endeavoring to form a prognosis, all the signs and symptoms must be noted and weighed: pain, tenderness, rigidity, distention, nausea and vomiting, delirium, intestinal obstruction, shock, the temperature, the rapidity of the pulse, the blood examination, etc. If all these elements, not only some of them, point to improvement, we may be reasonably confident that improvement is really taking place. If only some of them point to improvement, we will in many cases be altogether uncertain as to the significance of the change.

Diagnosis.—The diagnosis is not invariably certain, as many light-hearted operators seem to believe. It is frequently far from easy and is sometimes altogether impossible without exploratory operation. Sonnenburg maintains that we can diagnosticate the pathological condition of the inflamed appendix. Personally, I am unable to do this with any certainty, although

I always try, and am often right and just as often wrong.

In attempting to make a diagnosis, besides the ordinary examination of the abdomen a rectal or vaginal examination should be made, associated in many cases with bimanual palpation. If an appendix is enlarged and an individual has a thin abdomen which is not rigid, it is often possible to palpate the appendix. Sometimes it can be felt after the administration of ether when it could not be detected before. In an acute case forcible or prolonged palpation is always unjustifiable, as it may force an ulcer to perforate, or may rupture an abscess, and the information gained is not of sufficient importance to justify the risk. In a chronic case information of great value may be obtained and there is no real risk in the maneuver. I am persuaded John B. Murphy is correct in attaching the greatest possible importance to the order in which symptoms appear. Pain precedes nausea and vomiting, elevated temperature, and abdominal tenderness. If fever precedes pain, the condition is not appendicitis. If vomiting precedes pain, the condition is probably not appendicitis.

The disease may be confused with a number of different conditions. It sometimes is confused with typhoid fever; in fact, an early typhoid fever associated with marked abdominal pain gives a picture very similar to that

furnished by appendicitis.

In typhoid fever the temperature is usually distinctly higher than that commonly encountered in appendicitis. Maurice H. Richardson\* tells us that in every case in which typhoid is suspected, operation is not justifiable on the hypothesis of existing appendicitis, unless there are local pain and localized tenderness in the appendix region, associated with definite muscular resistance or distinct rigidity; and that operation should be postponed in a case in which the constitutional signs are severe and the local signs are difficult to detect; but when there are pain, tenderness, and rigidity with or without distention, operation must be performed, even when one recognizes the possibility of the existence of typhoid fever. Richardson lays down the following rule: Soft abdomen plus high temperature suggests typhoid, even if there are pain and tenderness. In appendicitis there is usually leukocytosis; in typhoid leukocytosis is absent, except when perforation is imminent or has occurred, or when some other complication exists. I have

seen the operation performed twice for supposed application in each case was found to be early typhoid fer

Acute intestinal obstruction is sometimes confus citis, and the mistake is particularly likely to occur to intussusception. In acute obstruction, as in a first appreciated about the umbilicus; but in acute in that region, does not pass to and localize itself and is not associated with tenderness of the right ilia the vomiting is persistent; in appendicitis, except usually trivial and often absent, although in childre persistent. In acute obstruction shock is much me appendicitis, and early and great distention of the a temperature in obstruction is usually subnormal; least in the majority of cases, the temperature is di ther, in acute intestinal obstruction the constipation cases of intussusception. In children, intussuscept ticularly confusing the diagnosis, because, after the fu unusual to have distinct fever in this condition, an like mass is found in the right iliac fossa; but in in does not remain fixed, but alters its position; it is m usually suffers from tenesmus and the passage of bloc bear in mind that in acute appendicitis associated acute obstruction may exist; and that the diagnosis made without recognizing the appendicitis.

Lesions of the kidney are sometimes mistaken renal colic the pain runs into the groin and testicle of ally passes down the front of the thigh or into the rec ness exists, it is found in the loin or in the groin, iliac fossa. Besides this, there are other symptoms urine may contain blood or pus, and there may be of frequent urination, though one should bear in m with inflammation of the vesical peritoneum there r urinary difficulties. An x-ray picture may exhibit or kidney, and a movable kidney is distinctly palpa colic there is vomiting in the beginning, just as in dicitis. In movable kidney the vomiting is often longed than is common in appendicitis. Movable may exist coincidentally. Very confusing cases are t accompanies appendicitis. I have seen it twice and i any apparent connection between the appendix and bladder. They must have been due to acute neph occur in some cases of appendicitis, the nephritis r of a bacterial disease. This form of nephritis Di toxique Appendiculaire." As pointed out by M. G. gery," Sept., 1908), hematuria may also be due to d kidney, ureter, or bladder.

Gall-bladder difficulties, too, may be confounded have operated upon a case of cholecystitis under was one of appendicitis; and upon a case of appendic adherent to the gall-bladder, in the belief that the condition was cholecystitis. In an inflammation of the gall-bladder, with a distended gall-bladder hanging low down, and with muscular rigidity, the distinction is always difficult and sometimes impossible. In ordinary gall-stone colic the condition is usually sudden in onset; it is characterized by pain in the epigastric region, passing toward the shoulder-blade and the shoulder, the pain being most acute and becoming more or less localized in the region of the gall-bladder; and there is always tenderness over the gall-bladder region. In gall-bladder colic the vomiting is violent and continuous.

The perforation of a gastric ulcer or of a duodenal ulcer may be diagnosticated as appendicitis. In perforation of a gastric ulcer there is usually history of previous difficulty with the stomach, though this is not always the case. The onset of perforation is sudden, with much greater shock than is characteristic of the onset of appendicitis. The pain is violent and the pain and rigidity and tenderness are in the epigastric region.

Among other conditions that may be confused with appendicitis may mentioned malignant disease of the cecum, tuberculosis of the cecum, cute tuberculous peritonitis, twisting of the pedicle of an ovarian tumor, bal disease, extra-uterine pregnancy, membranous colitis, perinephric abscess, tuberculous abscess of the loin or of the groin, and abscess from hip-int disease.

Pneumonia of the right base and pleurisy may cause abdominal pain and be mistaken for appendicitis. There may even be superficial tenderness the abdomen, but deep pressure is well tolerated (Donald W. Hood, "Brit. Med. Jour.," Dec. 30, 1905). There may be abdominal rigidity. The abdominal pain seldom persists for more than a few hours. It is intensified by deep respiration and is accompanied by high fever. As Hood says, whenever a patient suffers from vomiting, abdominal pain, and high fever examine the chest. In young children pneumonia is particularly apt to cause abdominal pain and rigidity. Beyond a doubt more than one abdomen has been opened for supposed appendicitis when the real condition was pneumonia.

In reaching a diagnosis in doubtful cases of appendicitis I believe that the blood-count is often of service. It is, of course, not to be maintained that the diagnosis of appendicitis may be made by counting the blood; but the blood-count may furnish evidence that, when added to the other signs and symptoms, may be of great importance. In nearly every case of appendicitis the hemoglobin is diminished by at least 30 per cent. In a catarrhal appendicitis or in an interstitial appendicitis the leukocytosis is trivial; but in cases of abscess or of gangrene of the appendix the leukocytes, as a rule, rise from 15,000 to 20,000. It is to be remembered, however, that when the patient is profoundly septic, the systemic condition is so depressed that leukocytosis is impossible; hence leukocytosis may be absent in trivial catarrhal cases or in grave cases with overwhelming general sepsis. This latter condition, however, is extremely rare. The blood-count will not help one in making the differentiation between appendicitis and an inflammatory disorder of the pelvis or abdomen, but will aid one in making a diagnosis from typhoid fever, intra-abdominal or pelvic neuralgia, and movable kidney (see J. C. DaCosta, Jr., study of 118 cases: "Am. Jour. Med. Sciences," Nov., 1901).

Appendicitis in Children.—The disease is much mo once thought (page 985). There is usually a history of gastro-intestinal disorder. The onset is apt to be sudde ous, the symptoms as a general thing are violent, and th ease is rapid. Vomiting is usually more violent and pro There is a great likelihood of pus formation, and gene common than in adults. Occasionally in young childr with so much pain and rigidity in the lower abdomer to point to appendicitis, and an attack of appendicitis n with or soon after a pulmonary inflammation. I hav children in which pneumonia was ushered in by abdom In children the appendix occupies a lower position than abdominal tenderness is usually lower than in adults, the reaches the right side of the pelvis, a painful point can g by a finger in the rectum, hence a digital rectal examin made. This usual involvement of the pelvis is respon and painful micturition which is very common (Karewsl the bladder symptoms are very prominent they domina and the bladder is thought to be the real seat of disease. in a child is more apt to result in general peritonitis than an adult (Selter). I agree with Springer ("Prag. med. xxxiv, Nos. 7 and 8) that operation in children should and that purgatives should not be given.

Appendicitis in Pregnant Women.—Appendicitis is a fortunately, a very rare complication of pregnancy. In 7, for appendicitis in the Mount Sinai Hospital of New Yor only 7 were pregnant (Cooke, in "N. Y. Med. Jour.," May states that in 30,000 cases under the care of the New Yor there were but 5 cases of acute appendicitis (Cooke, Ibid which occur in pregnancy have had previous attacks.

The condition may arise at any stage of pregnancy. rapid in progress, and accompanied by vomiting. Eapain and tenderness are significant and are located regnancy is absent. Cooke points out that later in pregbe so spasmodic as to cause them to be attributed to begin are often located in the region of the liver or even on the (Ibid.). Two hundred and fifty cases have been report been operated on (Renvall).

Appendicitis in the pregnant is far more dangerous tha In about 40 per cent. of cases abortion occurs, and a from infection. In some cases of successful operation to term. The diagnosis is often very difficult because o

Tuberculous Appendicitis (Fig. 523).—Acute symptosembling acute appendicitis. There is usually a history the stenosis existing at the ileocecal valve.\* There is a ing, and an abscess of large size is apt to form. The not always, is involved in the tuberculous process. Chipable enlargement, are sometimes mistaken for cancer of

<sup>\*</sup> Andrews, Annals of Surgery, Dec., 1901

Malignant Disease of the Appendix.—This is a very rare condition (less than of 1 per cent. of appendices removed for supposed inflammation). It is impossible of recognition clinically, but is sometimes discovered postmortem or during operation for supposed acute or chronic appendicitis or pelvic disease. Inflammation does not cause the malignant disease, but the malignant disease is apt to block the appendix and so cause inflammation. The condition may be carcinoma, sarcoma, or endothelioma, and usually there are distinct inflammatory changes. It is more common in women than in men. Rolleston and Jones collected 42 cases. McWilliams reported 3 cases and collected 45 not in Rolleston's table. This makes 90 reported cases ("Am. Jour. Med. Sciences," June, 1908). Since writing his article McWilliams has found 15 more cases reported. No case is counted in which the colon is diseased. The combined statistics show the average age of the patients to be only twenty-



Fig. 523.-Tuberculous appendix with perforation and abscess.

nine years. Two patients were only eight. In most cases the appendix alone is diseased; in some the colon or glands of the mesentery are involved. In three-fourths of the cases the growth is distal to the middle. Glands are involved late. Out of 90 cases in McWilliams' table only 8 had enlarged glands, and in 4 of these it was proved that the glands were not cancerous. In about 5 per cent. of cases concretions were found. The chance for permanent cure after removal of an appendix the seat of malignant disease is very good if the disease is limited to the appendix, and is particularly good if the growth is spheroidal-celled carcinoma (Rolleston and Jones). Metastasis is rarely noted. The growth is seldom larger than an almond.

Treatment.—If the diagnosis were always certain from the beginning, and if the case were seen at the very start by a surgeon, immediate operation in every case would be eminently proper. If this plan could be followed,

low the plan of treatment suggested by Ochsner to control peristalsis and favor limitation of infection. The patient is kept perfectly quiet, no cathartics are given, no food or drink is administered by the mouth, and thirst is allayed by enemata of salt solution. Nutritive enemata may be given. It is also my custom to place a hot-water bag instead of an ice-bag over the appendix region.

To permit peristalsis favors diffusion of the infection: to prevent peristalsis is to favor the formation of encompassing and defensive adhesions.

Many surgeons use the ice-bag, but I do not believe in it in these cases. We have already shown (page 99) that cold as a remedy for inflammation is useful only in the brief stage of hyperemia, and when a surgeon sees a case of appendicitis, there is certainly more or less stasis. Cold adds to stasis and does harm, and I am persuaded that the routine use of the ice-bag is responsible for some cases of gangrene. Again cold actually antagonizes the migration of leukocytes and the formation of adhesions.

Heat is a remedy which favors limitation of the process. It relieves stasis, stimulates the activity of the leukocytes, favors the formation of an encompassing barrier of phagocytic cells, and aids the cellular proliferation which leads to the formation of adhesions. Hence I prefer the hot-water bag.

The ice-bag, when applied before the diagnosis has been made, that is, in the earliest hours of the attack, when it might be thought to be most serviceable, allays pain and lessens rigidity in some cases, almost like a full dose of opium, and hence masks the symptoms as does that drug.

Opium should never be given until the diagnosis is made. In the first place, it is not needed, for if the pain is so violent as absolutely to demand opium, operation should be performed. In the second place, opium masks the symptoms, makes the patient feel comfortable, and gives the physician an unfortunate and ill-founded sense of security. The pain about the umbilicus, if severe, can be distinctly and safely relieved by the administration of thirty minims of spirits of chloroform every half-hour until three doses are taken. Opium should not be given if the surgeon, having decided not to operate at once, is awaiting an interval, because it may prevent or delay the recognition of some disastrous change. If a patient refuses operation, it can be given.

When we decide to wait for an interval, the case should be seen again within six hours. We are accustomed to follow McBurney's rule, which is as follows: If on seeing the patient again, six hours after the first visit, the patient is worse, operate at once. If he is no worse, there is no pressing danger.

If in twelve hours after the beginning of the attack the symptoms are not intensified, they will soon begin to abate; if the symptoms have become worse during this time, operate. If in twenty-four hours after the beginning of the attack the severity of the symptoms lessens, it is usually possible to wait for an interval; but if during the second twenty-four hours the abatement in the severity of symptoms has not gone on and there is doubt as to the condition, operate at once.\* When the attack has subsided, and about three weeks or more have passed, the appendix can be removed with remarkable safety. After a patient has had two or more attacks of appendicitis all surgeons agree that the appendix should be removed.

If pus is present some surgeons delay operation in the hope that firm \*For McBurney's views, see N. Y. Polyclinic, Jan. 15, 1807. adhesions will form around the pus, and that the n simply be the opening of an abscess. I do not be operation in a pus case. The pus may become limit pass up toward the liver or down into the pelvis. peril.

If only one attack has occurred, there may never question arises, Should the appendix be removed a do not know that a man has really recovered after pure Many cases reported as cured by medical means have operation. As Lockwood puts it,\* "To say that a has been cured by medical means is in many cases examan with a stone in his bladder has recovered from of a cystitis by rest in bed."

Even after a first attack, if the appendix rema tender after exercise, or if attacks of colicky pain occ

In some cases a single attack of appendicitis is dyspepsia and ill health, and in such cases operation In the majority of cases, after even one well-marken necessary. It is always necessary after two attacks (se dicitis).

Appendicitis cases which are far advanced in gener by the surgeon some operators decline to touch. If operating on such cases we will lose very many but we these few would have died if we had not operated. It tics, but occasionally saves lives. The operation sho incision to relieve tension and afford exit to infected of the appendix if it is easily accessible, otherwise drainage of the pelvis. After such an operation the Fowler's position and a continuous stream of salt solic caused to trickle into the rectum (see Murphy's Tr page 1006).

Appendicitis in a child is treated exactly as in a in a pregnant woman is treated as in the non-pregnar particularly indicated, and it is not proper to induce there is general peritonitis in a patient far advanced in proper to empty the uterus, primarily to obtain drainage a chance for life and secondarily to obtain a living chil

When operating upon a woman, bear in mind tuterine disease may have preceded, actually caused appendicitis; examine the adnexa and remove them if the state of th

An operation for tuberculous appendicitis is rath by a fecal fistula. An ordinary laparotomy is somet but the rule of operating should be, when possible, to and resect the diseased bowel. Andrews† mention to special cases of tuberculous disease: total excluslateral anastomosis, and the formation of an artificial

Congenital Idiopathic Dilatation of the Co Disease).—This condition is of prenatal origin. It r

<sup>\*</sup>Brit. Med. Jour., Jan. 27, 1900.

life or it may not become so until adult years, being aggravated and developed but not caused by habitual atony of the bowel. The supposed cause is an anatomical anomaly (perhaps elongation) leading to looping of the colon, a muscular aplasia leading to dilatation and valve formation. Various causes have been suggested.

The victim of this condition is obstinately constipated and has a distended abdomen, usually from early infancy, although, as previously stated, the condition may not manifest itself until childhood, youth, or even adult life. It is most difficult to get the bowels to move at all. Gay reported a case in which there was no bowel movement for three months and periods of several weeks are by no means uncommon. Now and then an attack of diarrhea may cause the emptying out of great quantities of feces. The abdomen is enormously distended and the patient is emaciated.

The abdominal veins are distended and the rectus muscles may be separated. In Finney's cases (as in some other reported cases) the cords of distended gut could be seen or felt to be more prominent on one side than on the other. There is no abdominal tenderness and pain is absent unless there is diarrhea.

Borborygmus is often very loud. Vomiting is rare.

The urine shows marked increase of indican.

The disease does not directly cause death, but the ill-nourished condition lessens the chance for recovery from any attack of illness.

Treatment.—Medical treatment consists of the ordinary plans for combating constipation. Some surgeons have removed almost the entire large intestine, others have performed entero-anastomosis, others colopexy, others have established a permanent artificial anus, others have made an artificial anus preliminary to entero-anastomosis. Finney believes that the operation of choice is resection of the affected gut followed by entero-anastomosis.

Splanchnoptosis.—This condition is due to relaxation of the abdominal walls and decrease of intra-abdominal tension, which leads to gradual stretching of suspensory ligaments and finally to movement of the viscera downward. The prolapse may involve all the abdominal viscera, one viscus, or several viscera. Prolapse of the stomach is known as gastroptosis (page 968); prolapse of the liver, as hepatoptosis (page 1021); prolapse of the spleen, as splenoptosis (page 1048); prolapse of the kidney, as nephroptosis (page 1273); and prolapse of the intestines, as enteroptosis or Glénard's disease (page 1001).

The causative relaxation of the abdominal walls is most common in women, but is by no means confined to that sex. It may be produced by ascites, pregnancy, muscular effort, febrile maladies, or wasting diseases. In some cases no cause can be assigned. Such a relaxed abdomen may be thin, but is not unusually thick, the fascial strands and muscular fibers are stretched, attenuated, and separated, the belly bulges downward and forward, and a viscus or the viscera follow because of lack of support.

Enteroptosis, or Glénard's Disease.—This disease is a prolapse of the intestine. It may be but a part of ptosis or prolapse of all the abdominal viscera; it may exist alone; it may be associated with movable kidney, prolapse of the stomach (gastroptosis), of the liver (hepatoptosis), or of the spleen (splenoptosis).

In Glénard's disease the intestines occupy the lower portion of the abdomen, and the belly below the costal margins is flat, is dull on percussion,

and the pulsations of the aorta are very evident. The transverse colon begins to descend first, and other tine follow. The splenic and hepatic flexures are enthere is venous engorgement of dependent parts of botte, in "Presse Med. Belge," 1901, Nov. 24). The are dyspeptic, anemic, and neurasthenic. The concapparent cause, may be caused by wearing corsets lifting heavy weights, and by prolonged vomiting. to dragging on the duodenum, the tube becoming flat The flattening of the duodenum may be followed by and in such a case the stomach dilates, otherwise it do the tenth rib is firmly attached by fibrous tissue to the tenth rib is freely mover atted from the ninth costal cartilage (Stiller's sign).

Treatment.-In many cases medical treatment lowing is the usual plan: Employ lavage, massage, proper abdominal support; insist on regular exercis and dyspepsia. There are two possible surgical pla vocates: (1) The suture of the prolapsed viscus to so the shortening by sutures of its supporting ligament. lessen the area of the abdominal wall and thus i tension. Depage makes the abdominal wall less in be in cases with separation of the recti, resects and sutures I believe that Depage's method of shortening the dia wall cannot permanently succeed, because the viscera ments, will eventually stretch the wall; it will be str damage done to its nerve supply by operation, and he and if it should, the patient will be worse off that course, whatever operation is done, diastased rectus m imated and sutured. For ptosis of the small intestir shortened, as suggested and performed by Davis of C

In prolapse of the transverse colon good results obtained by attaching the splenic and hepatic flexure (Lambotte's operation). The surgical treatment of properties of the liver, on page 1022 1048; of the kidney, on page 1276.

## THE PERITONEUM.

Acute Peritonitis.—Peritonitis, or inflammat is a common and usually a very dangerous disease.

Aseptic irritation by a traumatism or a chemical peritonitis, a condition which is strictly limited; w pain and tenderness; which may cause aseptic fever fibrin-ferment and the products of tissue change; whi of temporary or permanent adhesions, and which is repair.

Peritonitis, as the term is used by the surgeon, is Bæcteria may reach the peritoneal cavity by means or the entrance of foreign bodies; by extravasations i vermiform appendix, gall-bladder, urinary bladder, kidney, Fallopian tube, or uterus, or by the passage of micro-organisms through the damaged walls of any of these viscera or structures; by way of an open Fallopian tube; from the breaking of an abscess into the peritoneal cavity; from areas of necrosis due to volvulus, strangulation, or intussusception of the intestine; twisting of the pedicle of an ovarian tumor, a floating kidney, or a floating spleen; blocking of a mesenteric vessel by a thrombus or an embolism; gangrene of the pancreas or spleen, and fat-necrosis.\* In some cases the peritoneum may contain a point of least resistance, and bacteria contained in the blood reach this point and produce infection. It was once taught that cold could produce peritonitis, but it seems probable that it can only act by producing an area of least resistance. The capacity of the rheumatic poison to produce peritonitis is doubtful.

The peritoneum, as Byron Robinson pointed out and Fowler confirmed, is in reality a great lymph-sac, and peritonitis is lymphangitis. "When the peritoneum is infected the lymphatics furnish an exudate which clots in the lymph-channels, blocks them, and limits or prevents absorption. This blocking of the lymph-channels serves to preserve the life of the subject, on the one hand, while a failure in this respect, either because of the enormous and overwhelmingly rapid increase of septic material and the large size and number of channels necessary to destroy and obstruct, on the other hand, permits the destruction of the organism."† Absorption takes place most actively from the region of the diaphragm, hence peritonitis in this region is peculiarly fatal. Absorption takes place very rapidly from the intestinal region, although not quite so quickly as from the diaphragmatic area. Absorption takes place slowly from the pelvic region, hence peritonitis of this region is much less dangerous than is the disease in the intestinal region, and vastly less dangerous than is the disease in the diaphragmatic region (Fowler).

When severe bacterial infection of the peritoneum occurs, exudation of blood-liquor takes place, leukocytes migrate from the blood-vessels beneath the endothelial layer, particularly into the peritoneal cavity, and the causative bacteria rapidly spread about the cavity. The fibrinous exudate, in many infections, coagulates in masses on the free surface of the peritoneum and thus serves a useful purpose by blocking the lymph-channels and hindering absorption of toxins and bacteria. This fibrinous exudate may break down in a wide-spread suppuration or may be organized into an adhesion. In very virulent streptococcic infections a patient may die and there may be scarcely any coagulated exudation or may be none at all. Exudation and migration take place also into the subserous tissues and into the muscular coat of the bowel, and the segment of bowel which is attacked becomes paralyzed and distended with gas, the gas within causes it to rise up, and, as peristalsis is absent, obstruction occurs (James P. Warbasse, in "Am. Jour. Med. Sciences," July, 1905). Absorption of poison in peritonitis takes place in part from the peritoneal cavity and in part from the subserous tissues. Warbasse believes that the inflamed peritoneum is scarcely an absorbing surface, but in cases in which coagulated exudate has not formed

<sup>\*</sup>See Park's "Surgery by American Authors."
†George R. Fowler, "Diffuse Septic Peritonitis," in Medical Record, April 14, 1900.

or has been destroyed, it seems probable that it is an actiface, and absorption may occur from some regions, but no

Various bacteria may be responsible for peritonitis, lococci, streptococci, pneumococci, and colon bacilli. The spread most rapidly and widely are due to streptococci. infection the protective exudate does not coagulate, barr are not heaped up, encompassing adhesions do not form, sorption of toxins, and overwhelming systemic poisonir cause a very grave form of peritonitis, but less rapid and caused by streptococci—in fact, the process is often encom by coagulated lymph, leukocytes, and adhesions. The ome is thickened, and is apt to apply itself about the area of infecocci and pneumococci produce peritonitis which is more than that produced by colon bacilli. In most cases of p infection exists; for instance, colon bacilli and staphylococ and streptococci. In some apparently severe cases of acutures have remained sterile.

Forms of Peritonitis.—An accurate bacteriological cl as yet possible.

Peritonitis can be named, according to regions, pelvic, etc.; it can be divided pathologically into diffuse septic, pusuppurative, serous, and fibrinoplastic (Senn); it can be cally, into traumatic, puerperal, perforative, metastatic, scar it can be divided, clinically, into circumscribed suppurative, d and diffuse septic.

Circumscribed Suppurative Peritonitis.—In this confrequently met with in appendicitis, the area of infection by coagulated exudate, leukocytes, and adhesions, and after a time distinct localization becomes evident.

The symptoms of circumscribed peritonitis are pain, at then local, tenderness in a particular region, muscular ri vomiting, rapid and often wiry pulse, constipation, fever and dorsal decubitus with the thighs flexed. After a tim can usually be detected by palpation, and there may be dult local rigidity, irregular temperature, sweats, and possibly e wall. An abscess, though limited for a time, is always liable its walls and produce general peritonitis. Such an accided duced by muscular effort on the part of the patient or b pation on the part of the surgeon; its occurrence is ann and the symptoms of general peritonitis quickly arise.

Diffuse or general septic peritonitis is apt to destroy I peritoneum presents any marked change. Death ensues frof toxic alkaloids. Septic peritonitis may arise during pure lymphatic infection; it may be due to infection from without or an accident; to perforation of an ulcer; to gangrene of intestine; to rupture of an abscess into the peritoneal cavit of micro-organisms through a damaged wall of the bowe to perforation is called perjorative peritonitis. Perforation by a chill, shock, or rapid collapse. Gas may pass into the

and if it does so, the area of liver-dulness may be lessened or abolished. Symptoms and signs of hemorrhage may arise. Diffuse septic peritonitis is announced by a very rapid pulse, which is at first wiry and later gaseous; a temperature which may be at times febrile, but which is apt to be subnormal or which soon becomes so; diffused abdominal pain, general tenderness, dry tongue, delirium, persistent vomiting, constipation, and collapse. Rigidity may exist, and also intestinal obstruction; often, but not invariably, there is distention. In puerperal peritonitis or septic peritonitis from operation there is often no severe pain; in perforative peritonitis there is acute pain. Patients usually die within five or six days.

Diffuse or general suppurative peritonitis differs clinically from diffuse septic peritonitis in the fact that it is less apt to be fatal and wide-spread. In fact, adhesions may form about an area representing a considerable portion of the peritoneal cavity. The causes of both are identical. In septic peritonitis death occurs from absorption of toxins before obvious pathological changes occur in the peritoneum; in suppurative peritonitis the microbes are fewer, are less virulent, or vital resistance is more decided, and suppuration follows marked changes in the peritoneum. In suppurative peritonitis the pyogenic bacteria are always present, and there exists in the peritoneum a wound

or damaged area to constitute a point of least resistance.

Symptoms.—Chilliness or a rigor is common, followed by fever, the temperature rising to 102° or 104° F.; pain is intense, and is accentuated by motion and pressure; the attitude of the patient is assumed to relieve pain (he lies upon his back, with the shoulders raised and the thighs drawn up); there are vomiting, obstinate constipation, and rigidity of the abdominal walls, followed by distention when the intestine becomes paretic from septic poisoning. The pulse is rapid; is at first wiry, but may become gaseous, The constipation may be due either to tympanitic distention or to the shock and toxemia inhibiting intestinal peristalsis. Vomiting is frequent. In perforation gas often passes into the peritoneal cavity, and it may obscure the liver-dulness; in tympanites without perforation the liver is apt to be pushed up and its dulness often remains, but on a higher level. Pus unconfined by ad-Inesions will gravitate to the most dependent part of the peritoneal cavity. In some cases of suppurative peritonitis there is no tympanitic distention or rigidity; in some cases there is no fever, and a subnormal temperature may even exist.

Treatment of Peritonitis.—After an abdominal operation the patient may have pain, slight rigidity, constipation, nausea, etc., and the surgeon is in loubt if peritonitis is beginning. Our custom is in such cases to give a saline athartic, which will empty the peritoneal cavity of fluid, will favor the elimination of microbes, and will combat inflammation. The old-time remedy was opium, but Tait denounced it as inefficient, and showed that it masked the symptoms and often created a false sense of security in the very midst of imminent dangers. The usual method of administering salines is to give 3j of Rochelle salt and 3j of Epsom salt every hour until a free movement occurs. Administer an enema of turpentine at the time the first dose of the saline is given. This treatment will often abolish pain and distention and will perhaps prevent peritonitis after an abdominal operation. If, however, genuine peritonitis actually exists, operation is required. When diffuse septic or suppura-

tive peritonitis exists, the abdomen should be opened. If a perforation exists, it should be closed. If there is an inflamed appendix, it should be removed. Until recently it was surgical custom to break up adhesions, eviscerate, wash the belly with gallons of very warm salt solution, wipe out the space between the liver and diaphragm, wipe out the pelvis, wipe off the intestines, and remove masses of adherent coagulated exudate. We thus produced dreadful shock, tried to cleanse the peritoneal cavity when it is impossible thoroughly to cleanse it, carefully removed the exudate which was doing good by plugging the lymph-spaces, and yet did not reach the infection inside of the lymphatics, which is, after all, the greatest source of danger. Then we drained through two or more incisions and put the patient recumbent in bed, and thus permitted infected material to flow up to the diaphragm, where it is quickly absorbed. The mortality from this procedure was dreadful. John B. Murphy has taught us wisdom and has combined some of the conservative views of Ochsner with the use of the semi-erect position of Fowler, and with



Fig. 524.—Murphy treatment for suppurative peritonitis.

the continuous rectal irrigations that several advocated. Murphy's plan

is founded upon the following principles:

First, that the initial lesion of the peritonitis should be got rid of as quickly as possible and with the slightest possible amount of handling. For instance, we should remove a gangrenous appendix; we should close a perforation in the bowel, etc. Flushing of the peritoneal cavity with gallons of salt solution is inadvisable. It cannot thoroughly cleanse the peritoneum; it may diffuse the infection to regions that it had not previously reached, and it may tear up adhesions. Inflammatory exudate should not be removed from the intraperitoneal structures. It is nature's method of sealing the lymph-spaces; and if we remove it, we open thousands of channels, previously sealed, to the dissemination of the infection. A drainage-tube should be introduced through the operation wound, and a suprapubic incision should also be made, and a drainage-tube be carried through this into the pelvis. When the operation is completed, the patient should be placed in the semi-erect position, which is commonly called Fowler's position. This is done in order that the intraperitoneal fluids may gravitate away from the dia-

phragm, where absorption is extremely rapid, and into the pelvis, where absorption is much slower.

When the patient is placed in the bed, quantities of warm salt solution are passed slowly into the rectum. The mucous membrane of the large intestine absorbs fluid with great rapidity when that portion of the gut is in its normal condition of moderate distention. Overdistention leads to spasm, which expels the fluid. Hence the fluid must be given at low pressure and administration should be continuous. The simplest sort of apparatus is shown in Fig. 526. It consists of a fountain syringe, a large rubber tube, and a rectal tip of hard rubber. The nozzle that is used is angled, has one opening on the end and several on the side, and this nozzle is passed so that the angle fits to the sphincter. The tube is strapped to the thighs by adhesive plaster. The

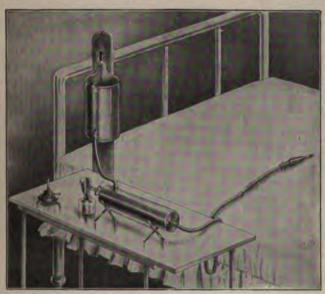


Fig. 525.—Alcohol or gas heater in operation, showing it properly connected. A short glass tube connects catheter to rubber tubing (Murphy).

hose that comes from the nozzle is attached to a reservoir, the base of which is hung from 4 to 6 inches above the level of the patient's buttocks; and the fluid, therefore, enters the rectum only about as fast as the rectum will absorb it. The reservoir is kept hot by bags of hot water. The fluid is allowed to enter continuously, unless it should run out from the side of the tube; if this happens, the flow may be cut off for a short time and then allowed to begin again. Gas from the bowel passes into the openings of the tube, and every now and then bubbles up through the reservoir. By this continuous, low-pressure instillation (proctodysis) an enormous quantity of fluid is absorbed by the rectum. In some cases a number of quarts are taken up in twenty-four hours. The absorption of this fluid greatly increases the amount of urine eliminated and stimulates the heart. The reservoir must not be high. Increase of pressure will cause expulsion of fluid and defeat the possibility of continuous administration. The plan so often followed of keeping the reservoir high and limit-

ing the flow by a clip on the tube is a mistake. Murphy says: "It should never have a headway of more than 15 inches hydrostatic pressure, and it gives the best and most uniform results at 4 to 7 inches" ("Jour. Am. Med. Assoc.," April 17, 1909). A straight tube is sometimes responsible for expulsion of the fluid, because it touches the posterior rectal wall of a patient in Fowler's position. Fig. 525 shows a more elaborate apparatus.

After the water has been entering the rectum for some time, a profuse discharge of sour-smelling material comes from the drainage-tube. This discharge may be profuse for one day, two days, or longer, when its sour



Fig. 526.—Proctoclysis apparatus consisting of fountain syringe, large rubber tube, and vaginal hard-rubber or glass tip (Murphy).

smell disappears and it greatly lessens in quantity. The outflow of this fluid from the wound means that saline fluid from the rectum has entered the lymph-spaces and flowed into the peritoneal cavity. Murphy thinks the lymphcurrent has been reversed. Whether this is true or not the peritoneum certainly seems to become a secreting instead of an absorbing surface, and the lymphatics are washed out. During the time that this treatment is pursued the patient has no food or water given him by the mouth. Stomach feeding is rigidly forbidden in order to prevent peristaltic movements. Small amounts of opium may be given to prevent peristalsis. If the patient is in a weak condition, stimulants or food can be given by the rectum, the solution in the reservior being allowed to reach a low level, and then the material that it is desired to give is poured in-Besides the above method of treatment antistreptococcic serum is given.

I am convinced that this method of treatment is of the greatest value, and that the principles upon which it rests are entirely soundand I have had a number of striking successes from its employment.

A circumscribed suppuration is treated as follows: Open the abscess. I will be possible, if the abscess is adherent to the abdominal wall, to open the abscess directly without opening the peritoneal cavity. If this is no possible, after opening the abdominal cavity pack gauze pads in such a manner about the abscess as to prevent the diffusion of pus when the abscess is evacuated. After opening the abscess the primary lesion is sought for and, if possible, removed. The surgeon should not, in most cases, tear away the abscess walls in an attempt to find the primary lesion, but should rather let it go undiscovered. Pack iodoform gauze against the intestines to reinforce the barrier of lymph and insert a tube. It is frequently advisable to leave the wound open and drain with iodoform gauze.

Every patient with peritonitis requires stimulants and frequent feeding withliquid food.

Tuberculous Peritonitis.-Tuberculosis of the peritoneum is not very

common. In 1170 autopsies in the Boston City Hospitol tubercle existed in some region in 197, and in 14 of these the peritoneum was involved.\* Primary local peritoneal tuberculosis is occasionally, though very rarely, seen by the surgeon. In a great majority of cases of peritoneal tuberculosis other distant structures are involved. In about half of the cases the lungs are involved. In 28 cases reported by Bottomly † not one was primary. In every one of these cases the diagnosis was confirmed by the microscope, by the tuberculin test, or by autopsy. In most supposed cases of primary peritoneal tuberculosis another focus of disease exists, but is not demonstrable by clinical methods or has been overlooked. The disease sometimes exists as a part of a general tuberculosis. Tuberculous peritonitis may be only a part of acute miliary tuberculosis. Bacteria may be swallowed with tuberculous food ora tuberculous patient may swallow tuberculous sputum and intestinal tuberculosis may result, the peritoneum being involved later. Peritoneal infection may follow a tuberculous lesion of the intestine, the bacteria may enter by way of the Fallopian tube, the initial lesion may be tuberculous appendicitis r tuberculosis of the mesenteric glands. The germ may lodge from the blood



Fig. 527.—Tube with orifices filled with chalk in order to show openings better.

lymph. The lymphatic form most commonly attacks the cecum. Tuberculous peritonitis is four times as common among women as among men, and most quently attacks those between twenty and forty years of age, but I have nit in a child of five and in a colored man of sixty. There are two groups cases—the common chronic form and the rarer acute condition. The ute form begins suddenly, and such cases, as pointed out by Lejars, resemble the appendicitis. In either the acute or chronic condition it is frequently case that pulmonary phthisis exists. Cirrhosis of the liver is sometimes and with tuberculous peritonitis. There are three forms of chronic tuberous peritonitis: the ascitic, the fibrinoplastic, and the caseous,‡ although, a matter of fact, these so-called forms are only stages of the same disease. Derculous infection may exist for some time without causing symptoms, te symptoms may suddenly arise, or intestinal obstruction may take place. In other cases the uptoms appear gradually and progressively grow more positive.

Symptoms of the Chronic Form.—Usually the disease begins insidiously. The digestion is found to be disturbed, there is nausea, the bowels are out of

<sup>\*</sup> Bottomly, in Amer. Med., Feb., 15, 1902. † Amer. Med., Feb. 15, 1902.

order, the abdomen is distended and tender, the and the patient is weak, loses flesh rapidly, and quently pain is the symptom which leads the pain may be present from the very beginning, gastro-intestinal disorder have existed for som will develop.

In many cases there is ascites, but the amou In some cases the fluid is serous, in some serop in some bloody. Chylous fluid occasionally ex tion of tuberculous masses. Ascites may be eith adhesions. In some cases, and especially in e ascites, and the condition is characterized by the adhesions which bind coils of intestine to each stomach, liver, and other viscera. In this co slowly, small cavities are formed between adh fluid and bacteria. This is the most chronic for of tuberculous peritonitis the mesenteric glands moderate fever, but there may be episodes of his of subnormal temperature, or the temperature evening and subnormal in the morning. WI markedly elevated, pain, tenderness, and dis some cases there is a continued fever resembling tions may be detected. These formations may encysted exudate, or enlarged mesenteric glands period, there is probably tuberculous ulceration

In every suspected case a bimanual exami ether, in order to discover if there are any matt son).

In many cases a careful examination will det regions of the body, particularly of the lungs. lungs or pleura is detected, if tuberculous glar if a nodule not due to gonorrheal inflammation or if there are indurations in the prostate, the tuberculous peritonitis is much enhanced. In of the superficial abdominal veins. In some undergoes spontaneous cure. In the majority the tuberculous peritonitis directly or from asso other organs.

If an intraperitoneal tuberculous area case form, and such an abscess may break into the ternally, and may be responsible for the forma

In a case of tuberculous peritonitis intesting ut getting caught by bands or adhesions, or be the formation of tubercles.

Symptoms of the Acute Form.—This is so dicitis. It comes on rather suddenly, but a usually show the previous existence of malaise loss of flesh, and anemia. The symptoms are right iliac fossa as in appendicitis. There are

tain amount of rigidity, nausea and vomiting, colicky pain which may be very severe, general abdominal tenderness, fever, and exhaustion. It may be possible to palpate masses like tumors, or to feel nodules in the prostate

or epididymis, or to detect tuberculosis in some other part.

Treatment.—In some cases there is a tendency to spontaneous cure, and in them medical treatment is of great service. The patient should be placed un der antituberculous conditions (page 245), nutritious food and tonics should be administered, the abdomen should be counterirritated and massaged, and purgatives should be given frequently. Guaiacol applied daily to the abdomen is thought by some to be of service, but I doubt it. A mixture is made of 1 part of guaiacol and 5 parts of olive oil; one dram of this mixture is rubbed into the a bodomen, and the part is covered with a piece of flannel held in place by means of a binder. If medical treatment is not soon productive of benefit, the advisability of operating must be considered. It is a curious fact, but one confirmed ample evidence, that after simple abdominal section, without the introduction of germicides and without drainage, at least 30 per cent. of the cases recover from the disease in from six months to one year. Some surgeons doubt the curative effect of operation. For instance, the late Professor Fenger was strongly of the opinion that many patients recover after operation, but not as a result of operation. In his opinion they recover because they were strong, free from fever, and well nourished, and because the disease tended to spontaneous cure. He further believed that some died from operation because the traumatism lessens the already lowered tissue resistance. The majority of surgeons, however, believe that operation in many cases tends cure. Ochsner, in a paper before the American Surgical Association in 1902, Proved that simple incision and evacuation of fluid tends to cure. It is uncertain how an operation tends to cure. It has been thought that the ascitic fluid is a culture-medium for bacilli, and when it is withdrawn the bacilli die, but opposed to this view is the fact that aspiration is rarely curative. It has been suggested that the operation brings numerous phagocytes to the Peritoneum; that it stimulates vital resistance; that it leads to the exudation of antitoxic serum. The entrance of air seems to play a definite and important Part in effecting a cure.

The ascitic cases are most frequently benefited by operation. In en-

Isted fluid operation often cures.

In cases in which there are numerous adhesions operation is not so likely to produce a cure. Great care should be exercised in separating adhesions, cause the bowel is apt to be torn and a fecal fistula may result. It may be essary to separate adhesions or short-circuit a portion of gut to relieve struction. Drainage should not be used unless a cold abscess exists. Not a drainage of no service, but it is dangerous; death is more apt to ensue a drained case and a fecal fistula will arise in nearly one-fourth of the cases. Operation is performed for cold abscess, tube-drainage must be used for some days. In a woman with tuberculous peritonitis the abdomen should be pened in the mid-line, and if the Fallopian tubes are tuberculous, they should be removed. In a man the incision should be made over the appendix, and if this is tuberculous, it should be removed. In either sex it may be necessary to resect tuberculous intestine or perform anastomosis because of stricture. (In confirmation of these views see W. J. Mayo, in "Jour. Am. Med.

Assoc.," April 15, 1905.) The Mayos have performed 26 radical tubal operations on cases of tuberculous peritonitis and 25 recovered. Of these, 7 had previously been operated on from one to four times by simple laparotomy ("Jour. Am. Med. Assoc.," April 15, 1905). In a very advanced case, in a case with notably high temperature, or in a case with marked and advancing tuberculosis in another region, an operation should not be performed except to relieve obstruction or drain an abscess. If a patient does not die within a few months after the operation, he will probably recover, and in most cases operation secures at least temporary improvement (Bottomly).

The mortality from operation is 1 or 2 per cent. (Fenger).

Pneumococcus Peritonitis.-This condition is an unusual one. It is most apt to arise during the progress or after the termination of pneumonia, but is sometimes primary-is far commoner in females than in males and in children than in adults. Out of 74 reported cases, 57 were children under five years of age (Dr. Max von Brunn, in "Beiträge zur klinischen Chirurgie," Bd. xxxix, Heft i). The condition may appear in a sufferer from otitis media. The symptoms in children are sudden in onset. The first symptoms are general abdominal pain, usually a continuous pain with colicky exacerbations, tenderness, rigidity, vomiting, elevated temperature, distention, and diarrhea. In a few days the symptoms abate and some of them disappear, although pain, tenderness, and rigidity are apt to localize at some point, particularly about the umbilicus, and perhaps remain for a number of weeks. In such a chronic case physical signs of a fluid collection are usually demonstrable. In the chronic stage, as Brunn points out, there is seldom severe tenderness and there may be no fever at all, and a septic temperature is very rarely observed. Pus may form, and if it does, it contains pneumococci. Adhesions practically always form. These adhesions glue the intestines together and often encompass pus. Rapid emaciation and progressive weakness are always noted. In adults the symptoms are irregular and less characteristic than in children (Brunn). The prognosis is excellent.

Treatment.-Is incision and drainage.

Subphrenic Abscess.—A subphrenic abscess is a collection of pus beneath the diaphragm. The pus, as a rule, occupies a part of the lesser peritoneal cavity; in rare instances it is extraperitoneal (when it is of renal origin); in some cases it is contained in the area between the diaphragm, cardiac end of the stomach, and liver or spleen. It is an unusual thing for such an abscess to break into the general cavity of the peritoneum, but it may break into the

pleural sac (Maydl).

Causes.—Perforation of a gastric ulcer, perforation of the gall-bladder or gall-ducts, ulceration of the duodenum, disease of the liver, spleen, pancreas, intestine, appendix, or kidney, hydatid disease, internal injury, metastasis, external injury, caries of rib, or disease of the pleura may be responsible for a subphrenic abscess (Maydl). Charles A. Elsberg\* has collected 73 cases of subphrenic abscess after appendicitis. He points out that the condition may arise from direct extension or by way of the lymph-channels, and may be either intraperitoneal or extraperitoneal, although in the majority of cases it is intraperitoneal. In all but seven of these cases there was suppuration about the appendix. The pus was thick and foul in all the cases. In 15 per cent. of

<sup>\*</sup>Annals of Surgery, Dec., 1901.

them gas was also present, and in 25 per cent. of these cases the diaphragm was perforated. In one case on which I operated the abscess developed after cholecystitis.

Symptoms.—A patient with subphrenic abscess usually complains of pain in the lower part of the chest on the right side. The area of liver-dulness is distinctly enlarged, and there is tenderness in the lower part of the right chest when pressure is made through one or through several intercostal spaces. Frequently friction-sounds may be heard about the region of the dome of the liver. Sometimes the symptoms are obscure or indefinite, and not accompanied with particular pain. If the abscess happens to contain a considerable a mount of gas, and about one-half of such abscesses do contain gas, not only will there be no increase in the area of liver-dulness, but the normal rea of dulness may be diminished or obliterated. The presence of gas is due to some connection with an organ which contains gas. It is very common for a pleural effusion to be associated with a subphrenic abscess. A pleural effusion will be preceded by or accompanied with symptoms pointing to the lung or pleura; and it is to be remembered that the area of percussiondulness found in the pleural effusion shifts its position whenever the position of the patient is changed, which is not true of the area of dulness found subphrenic abscess. When the abscess breaks through the diaphragm, the patient develops collapse, cough, and other thoracic symptoms; and if the abscess breaks into a bronchus, the patient will expectorate pus. In subphrenic abscess the diaphragm of the diseased side is paralyzed—a condition rarely met with in liver-abscess. There are general symptoms of Suppuration and a swelling in the subdiaphragmatic region following some recognized causative condition. The history of chills with recurrent fever and sweats is rather indicative of abscess of the liver; but in abscess of the liver there is usually pain in the shoulder-blade of the right side, and this is rarely encountered in subphrenic abscess. The proof of the diagnosis is not, however, Dtained until an exploratory incision has been made and the purulent matter has been examined. In many cases the abscess-cavity will be found to contain sas as well as fluid. Empyema and subphrenic abscess resemble each other. In empyema the upper limit of the fluid is concave; in subphrenic abscess it is COnvex. In empyema the flow of pus through an aspirating-needle will be most marked during expiration; in abscess, during inspiration. The same is true of the rush of gas. In empyema the needle does not oscillate; in abscess it does.\* If an abscess contains gas, percussion elicits a tympanitic note over a part of the cavity and there is an alteration in the area of tympany with an alteration in the position of the patient. An abscess of the liver almost never contains gas and decidedly changes the outlines of the organ.†

Treatment.—Incision and drainage. The incision in some cases may be made in the lumbar region, in some cases through the abdominal wall (epigastric region, iliac region, hypochondrium). In other cases the chest-wall is incised, the ninth or tenth rib is resected, and the abscess is opened below the pleura or the pleura is opened and the diaphragm is incised. If appendicitis is the cause, be sure the appendicitis is well; and if not, open and drain freely

<sup>\*</sup>Wharton and Curtis, "Practice of Surgery."
†In a case of abscess of the liver secondary to appendicitis operated upon in the
Jefferson Hospital the abscess did contain gas produced by gas-forming bacteria.

(Elsberg). If it is necessary to open the pleural sac, first try to stitch the parietal to the diaphragmatic layer of the pleura, or, if this is impossible, protect the cavity with iodoform gauze to prevent infection.

THE LIVER, GALL-BLADDER, AND BILE-DUCTS.

Rupture and Wounds of the Liver.—Rupture of the liver is due to very great force, and is usually accompanied by injury of other viscera. It may be produced by a blow, by a fall, or by the end of a broken rib. The superior surface or margin most often suffers. It is a very fatal accident. Out of 543 reported cases, over one-half died of hemorrhage within twenty-four hours of the accident.\* At least 80 per cent, will die if not operated upon. Wilms† collected 19 cases, and only 3 recovered after operation. Eisendrath ‡ has collected 37 cases of suture of the liver for rupture and 22 of them recovered (59.5 per cent.). The first operation was performed by Willette in 1888. An attempt should be made to save the patient by opening the abdomen and arresting hemorrhage, and in a suspected case an exploratory operation should be performed. A wound of the liver causes violent hemorrhage which is usually rapidly fatal. Such a wound is apt to divide bile-ducts and allow bile to escape into the peritoneal cavity. Bile, if sterile, will do little harm, but if it contains bacteria, it will produce diffuse peritonitis. Even sterile bile is corrosive and may cause fibrous peritonitis. The symptoms of a rupture or wound of the liver are those of severe intraabdominal hemorrhage, with collapse, hepatic tenderness, and respiratory embarrassment. Soon after the injury the abdomen is soft and flat, but it quickly becomes rigid and ultimately distended. The diagnosis becomes more probable when it is known that violence was applied in the hepatic region. Usually there is abdominal pain and often pain in the back. Sugar may appear in the urine. In a few cases after several days jaundice and skin itching have been noted. The area of liver-dulness is usually increased. Patients do not always die from a serious traumatism of the liver. Some recover because operation has been performed. Some few recover without operation. This last fact is proved by reports of autopsies in which scars were found in the liver-parenchyma (Nussbaum). The fatality which usually ensues on a liver injury may be due to hemorrhage or peritonitis. If a surgeon is called to a patient suffering from wound of the liver, he must open the abdomen to arrest hemorrhage. If a penetrating wound is suspected, it may be desirable to enlarge the wound in the abdominal wall layer by layer, in order to determine that the liver is wounded. If the left lobe of the liver is wounded, or if it is uncertain which lobe is wounded, the incision should be median. If the right lobe is wounded, a curved incision is made along the line of the costal cartilages. In some cases these two incisions are joined.§ The convex surface of the liver can be reached by Lannelongue's plan. Lannelongue resects the eighth, ninth, tenth, and eleventh costal cartilages and draws the ends of the ribs well out. It can also be reached by Langenbuch's plan, that is, by cutting the coronary ligament and the right lateral ligament. This allows the liver to be pulled well up into the wound in the belly

<sup>\*</sup> Mercade, in Rev. de Chir., Jan. 10, 1902. † Deut. med. Woch., Nos. 34 and 35, 1901. ‡ Jour. Am. Med. Assoc., Nov. 1, 1902.

<sup>§</sup> See Schlatter, Beiträge zur klinischen Chirurgie, Bd. xv, Heft ii. 1896.

wall. The site of the wound can be discovered if the hepatic vessels are grasped between the thumb and a finger (the finger in the foramen of Winslow and the thumb in front on the gastrohepatic omentum). This completely rests hemorrhage, and the blood that has gathered may be sponged out and the wound sought for in a clear field (see Pringle, of Glascow, in "Annals of Surgery," Oct., 1908). When the wound in the liver is discovered and well exposed, deep sutures of catgut should be inserted in the liver and the cap-It should be stitched with fine silk (Schlatter). If sutures fail to arrest hemhage, the liver should be sutured to the belly-wall and the wound in the Liver packed with iodoform gauze. It is useless to try packing without first at taching the liver to the abdominal wall, because pressure will simply push the liver away and will not arrest the bleeding. The cautery is a very useful cans of arresting bleeding. It should be avoided if possible in a large wound, because, even if it arrests primary hemorrhage, secondary hemorrhage may occur. After arresting hemorrhage, wash out the abdomen with hot saline fluid, insert drainage, and close the abdominal wound. In a case of the thor's in the Philadelphia Hospital the liver was wounded by the sharp ends of fractured ribs. The abdomen was opened, a wound was found, and bleedwas arrested by suturing the liver to the belly-wall and packing the wound. The patient died, and necropsy showed another wound on the posterior portion of the organ. The possibility of such an occurrence should not be lost sight of.

Tumors and Cysts of the Liver.—The liver may be the seat of Primary carcinoma, sarcoma, or endothelioma, of angioma, lymphangioma, adenoma, fibroma, myxoma, or lipoma. Many tumors called adenomata are really adenocarcinomata. Secondary malignant growths are far more common than primary neoplasms-in fact; 96 per cent. of liver tumors are secondary. Primary cancer of the liver is found once in every 2000 autopsies (Eggel). The commonest variety is the nodular, but the diffuse form, known as cancerous cirrhosis, may occur. The nodular form is most often encountered in the right lobe, and it has been found in persons under the age of twenty. Metastases occur early. "There is always more or less coexisting cirrhosis of the liver" (Leonard Freeman, in "Trans. of Am. Surg. Assoc.," 1904). It takes origin from the hepatic cells. The frequency of cancer of the liver secondary to cancer of the stomach has already been alluded to. The commonest primary tumor of the liver is cavernous hemangioma. It is especially apt to take origin in the atrophying liver of an elderly individual. Primary 5arcoma may arise at any age and may even be congenital. The growth is rapid and emaciation is soon noted. The liver enlarges, often greatly. Jaundice and ascites are rather rare. The patient soon becomes very weak. There is always pain. As Knott points out ("Surgery, Gynecology, and Obstetrics," Sept., 1908) the condition may simulate abscess, and if it arises in a middleaged or elderly person can scarcely be differentiated from carcinoma.

Knott (Ibid.) has collected 50 cases of primary sarcoma from literature, and adds 14 reported by personal communications, and 1 of his own, 74 in all. He shows that 28 cases have been operated upon. In 9 the operation was exploratory and no attempt was made to remove the growth. In 19 the

growth was extirpated, with 10 recoveries and 9 deaths. One of these patients was well after nineteen months, I after two years, I after seven months.

Operation is indicated for a circumscribed growth,

Among the cysts occurring in the liver are blood cystille cysts, and hydatid cysts. Terrier and Auvray in 190 tions for hepatic tumors.

Angiomata have been removed successfully by hepa knife at a red heat being used to cut through the normal libase of the tumor, the large vessels being tied with of is not feasible because of excessive hemorrhage. If a turthe base may be encircled by an elastic ligature held in pla and five or six days later the tumor may be cut across wassisted Prof. Keen in such an operation.

Carcinoma of the liver has been extirpated, but it is s is recognized early enough and is found to be sufficient such a procedure. Operation is proper only when there is primary cancer. In 1901 Terrier and Auvray collected mary cancer. In most cases there has been rapid recurging growth, but Schrader's case was well at the end of sever Freeman's at the end of sixteen months. (For operative notes Freeman, in "Trans. Am. Surg. Assoc.," 1904.) Hu 96 cases of resection of the liver with a mortality rate of 26 the best method of arresting hemorrhage is the use of suture catgut passed by blunt needles, as advised by Mikulicz.

Hydatid cysts of the liver may be of small siz no signs or symptoms; or may be of large size and produ tumor. In the epigastrium the mass may be prominent In cyst of the right lobe the dulness is found in the axillary encroaches on the pleura. In a large cyst fluctuation a may exist. Hydatid fremitus is a vibration imparted to of one hand when the fingers of the other hand knock up may be no discomfort produced by even a large cyst, but, suffers from a dragging sensation in the epigastrium and Suppuration in the cyst produces the symptoms of abso septicemia. Rupture of the cyst produces shock and evmay take place into the pleural sac, the lung, or the peritshock is recovered from, inflammation arises, the area of the structures damaged. The escape of even a small qua into the peritoneal cavity produces urticaria (hydatid to. for diagnostic purposes is not advisable.

Treatment.—Exploratory incision may be necessary nosis, and the operation is completed at this time. After it is packed around with gauze and a trocar is introduced siderable thickness of liver tissue over the cyst, incise the I knife. When the fluid is evacuated, the sac is incised a through the wound in the abdominal wall, and is attached gins (marsupialization). The endocyst can then be remained by irrigation. A large drainage-tube is introduced.

Syphilis of the Liver.—This is a tertiary lesion. irregular patches of inflammation in Glisson's capsule eventuate in hepatic sclerosis)—as a large solitary gumn

<sup>\*</sup> Russell S. Fowler on "Tumors of the Liver," Brooklyn Medic

of cases of gumma present a solitary lesion)—or as multiple, and usually small gummata. Gummata are most usual upon the anterior surface of the right lobe. The large gumma is often mistaken for cancer of the liver and it is a curious fact that in hepatic gummata we are often unable to obtain any history of syphilis. Syphilis may be mistaken for ordinary cirrhosis, but in the latter disease the general nutrition is more impaired than in the former, and vomiting of blood, dilated cutaneous veins, ascites and indigestion are far more apt to be present (Archibald MacLaren, in "Annals of Surgery," August, 1908). These patients are apt sooner or later to develop jaundice, colicky pain, moderate fever, and palpable enlargement of the liver.

Treatment.—Mercury and iodid will cure most cases. If these drugs fail, it is proper to remove the tumor, if solitary, by resecting the involved area of the liver. MacLaren (Ibid.) collected 9 cases of resection for solitary gumma

and added 1 of his own. There were 2 deaths in this series.

If an area is opened for exploration and a solitary gumma is discovered, the abdomen should be closed and specific treatment be tried before resorting

to resection, that is, if specific treatment has not been tried before.

Abscess of the Liver.—An abscess of the liver may be produced by bacteria, especially staphylococci and streptococci. These organisms reach the liver by the general circulation, or, what is more frequent, are taken up from the intestinal tract and reach the liver by the portal circulation, or pass to the liver by the lymphatics. Appendicitis with lymphatic infection may result in hepatic abscess. A subphrenic abscess may break into the liver and thus induce a liver abscess. Liver abscess may directly result from peritoneal infection. The fact that abscess of the liver is in hot countries frequently preceded by amebic dysentery led to the presumption that amœba coli produces the abscess, and in a large majority of cases of tropical abscess amebæ exist in the pus or at least on the abscess walls. Habitual intemperance and constant overeating predispose to abscess of the liver. The disease may follow traumatism, dysentery, diarrhea, cholangitis, suppuration of a hydatid cyst, gall-stones, typhoid fever, appendicitis, and a chill to the surface of the body.\* Abscess of the liver may be metastatic, and such abscesses are multiple. It may be caused by foreign bodies and parasites. A tropical abscess is an abscess of the liver in an inhabitant of a hot country.

There are three forms of abscess of the liver: traumatic, pyemic, and

tropical.

Traumatic abscess may result from a wound of the liver or may follow a contusion without a break of the skin. In the latter case bacteria from the blood are arrested in the injured liver tissue. Such an abscess is usually solitary. Streptococci, staphylococci, or colon bacilli may be found.

Pyemic Abscess.—Multiple abscesses exist, but they may fuse into one. It is frequently due to suppurative inflammation of radicles of the portal vein, infected emboli forming and reaching the liver; it may follow ulceration of the

intestine, hemorrhoids, or appendicitis.

Occasionally abscess may arise from the extension of an infective process, such as pylephlebitis, or in cholelithiasis with obstruction. In these latter cases both the bacillus typhosis and the pneumobacillus of Friedländer have been found as the direct bacterial agent. Colon bacilli are a common

<sup>\*</sup>G. B. Johnston, Annals of Surgery, October, 1897.

cause. Abscess of the liver following appendicitis in fection (portal pyemia) or to lymphatic infection. but in a case of mine in the Jefferson Hospital it was having probably joined to form one. Echinococcu suppurate and form abscess. I operated unsuccess which was brought to me by Dr. Hultsizer. The row and the balantidium coli sometimes cause abscess, and served in measles, epidemic influenza, and perforating

Tropical Abscess of the Liver.—Tropical abscin temperate climates, but is extremely common in antecedent in either climate is dysentery. The reason of the disease in tropical regions is that the chief caucoli, is found widely distributed in hot countries; and of the liver is a common condition among the white regions. It has been pointed out that tropical abscess among white persons that abuse alcohol, the condition of the liver making that organ a nutritious soil for a disposing factors are protracted malaria and chilling body.

Major Charles F. Kieffer, U. S. A., † in a lecti of the liver, states that in his own experience he fou scess cases in soldiers, that dysentery was present in a second series of 25 cases in natives and civilia of dysentery in 22 cases. Some observers-notab dysentery is the antecedent factor in 97.5 per cent. out that in all the figures allowance must be made dysenteries, as well as for cases in which no effort was of dysentery one or two years previously. It is also a case of amebic infection of the colon may have been as to have caused but a transient diarrhea, which th gotten. Again, as Kieffer observes, amebæ occasio without producing any dysenteric evidences. His co 20 to 25 per cent, of severe amebic dysenteries lead to of the liver, and that at least 85 per cent. of all trop infection with the amœba coli. Occasionally, an a after the dysentery; but, as a rule, it does not for ward-weeks, months, a year, or even two years.

When an abscess of this sort forms in the liver, larged and congested, and an area or areas of necro abscess may be present; there may be an abscess with it; several abscesses may coalesce, making a very l multiple abscesses may exist. In about 70 per cent tropical abscess is solitary (Kieffer).

The right lobe of the liver is the region most fre abscess is found in the right lobe in from 70 to 80 it is more often toward the convexity of the liver than

An abscess of the liver contains characteristic

<sup>\*</sup> Major Chas. F. Kieffer, U. S. A., in Phila. Med. J. † Phila. Med. Jour., Feb. 21, 1903.

it is different from the pus found in other abscesses, and, in fact, is not pus, but is necrotic liver-substance. Liver abscesses due to pyogenic organisms contain true pus; a tropical abscess, free from pyogenic infection, does not. Ordinary pus contains hordes of leukocytes; but the pus of a tropical abscess contains very few. Riesman is of the opinion that the reason there are so Few leukocytes is that the abscess contains a substance that, by chemotaxis, repels leukocytes. The pus is of a reddish-brown color, is thick, and frequently contains some blood. Occasionally it is offensive in odor. Microscopic 'examination shows it to contain portions of necrotic liver tissue, some liver-cells that are not destroyed, elastic tissue, blood, pus-cells, and amebæ (Kieffer). On bacterial examination it may be found that the pus is infected, containing staphylococci, streptococci, or pyogenic bacteria. In about 20 per cent. of the cases the pus contains neither bacteria nor the amœba coli. In over 60 per cent. of the cases the pus of a recently opened abscess is free from bacteria. In cases in which the fluid is sterile it is possible that bacteria were originally present, but have died. The reason for the death of micro-organisms in this pus is in great doubt; because, as Riesman points out, bile cannot kill them, and organisms may be grown in the pus. Kieffer says that in the large majority of cases amebæ are readily demonstrable in the pus; but that in some few cases it is necessary to rub a piece of gauze on an abscess-wall in order to obtain amebæ, and that in others they can be demonstrated only after the abscess has been discharging for some days. The causative rôle of the amœba has been doubted by some observers, but most surgeons who have had experience in the tropics believe it to be a fact.

Symptoms.—The symptoms may be very definite and positive; they are frequently misleading and obscure; and in some cases nothing whatever directs the surgeon's attention to the liver until the patient passes a huge quantity of pus at stool or coughs up an enormous amount of the characteristic material. If rupture takes place, death usually ensues. As a rule,

the symptoms of a tropical abscess are positive and marked.

Kieffer sums up the chief symptoms under four heads: fever, sepsis, en-Largement of the liver, and pain. In about three-fourths of the patients fever and sweats are definitely present; in about one-fourth they are absent or are very trivial. The type of fever met with is what has been previously spoken of as hectic. Usually there is an evening rise, preceded by a chilly sensation or by a chill; and as the temperature begins to fall, toward morning, there is a profuse sweat. It is seldom that there is any violent chill, though there is frequently a slight one. The sweats are extremely exhausting. They may occur either during the night or in the daytime, according to the time in which the patient sleeps. Kieffer says that they should not be called night-sweats, but rather sleeping-sweats. In very chronic cases there may be no pyrexia. As a rule, the temperature resembles that of malaria, but it is not controlled by quinin and the blood is free from malarial parasites. Sometimes the temperature suggests typhoid, with the exception that from time to time there are episodes of subnormal temperature. The patient loses flesh and strength, the appetite fails completely, and the skin becomes pasty or dirty yellow.

The entire liver is usually enlarged, and the enlargement may be detected

by percussion, and in some cases a hard, smooth area can be times the liver reaches as high as the third rib anterior of the scapula behind, and it may extend downward to the spine of the ilium. It is rarely, however, that the place in a downward direction; it is usually upward. I right side of the chest appears to be rather full, and actual obliteration of several intercostal spaces. If an a herent to the surface, there may be skin edema and downward in very rare instances, if a very large abscess comes near the tion may be obtained. By auscultation it is frequently friction-sounds in the region of the diaphragm and the the liver.

The liver becomes tender. This tenderness may ticularly by pressure upon the lower edge of the organ, pressure through the intercostal spaces. There is not as a rule, there is. The pain may be dull and heavy; nears the surface of the organ, the pain becomes shar The pain is persistent and is not strictly localized, but ra the right shoulder-blade, and the point of the shoulder. I pressure, coughing, sudden or violent movement, and is the esophagus when food is swallowed. When the upper is involved, the patient breathes as if he had pleurisy; and does develop, with marked effusion.

Paralysis of the diaphragm rarely occurs in abscess or respiration is not much affected, unless the diaphragm or pleura become involved, though the patient frequently A severe cough suggests that the abscess is on the conforgan. Such a cough is aggravated by recumbency. Kiesthe patient lies on his right side, and almost on the right shoulder being drawn down and the right knee drawn tension of the abdominal muscles. In about one-fourth of abscess of the liver jaundice occurs; usually, however, it the abscess is on the inferior surface. Jaundice does not common or hepatic ducts are compressed or cholangitis exicution to a particular help in the diagnosis, as there is leukocytosis. The urine is usually scanty. Diarrhea is paniment, but constipation may exist, and nausea and a means unusual.

Diagnosis.—With an antecedent history of dysenter easy. Without such a history, it is always difficult and In the tropics exploratory aspiration is freely used, but e with subsequent exploratory aspiration, if necessary, wou and more certain.

Symptoms of Traumatic Abscess.—Are similar to those Symptoms of Pyemic Abscess.—The liver is enlarged is slight jaundice, and the general symptoms of pyemia a

Treatment of Tropical Abscess.—Make an explorator abscess is adherent to the parietal peritoneum and is no substance, at once proceed to operation. If it is not adh

by a considerable layer of liver substance, stitch the visceral peritoneum to the parietal peritoneum and postpone further interference for forty-eight hours. The operation consists in evacuating the pus with a trocar and cannula, incising the abscess, stitching its edges to the edges of the abdominal wound, irrigating, and inserting a drainage-tube. If the abscess is covered by a layer of liver tissue, after locating it with an aspirating cannula open into it with a cautery knife and arrest hemorrhage by packing. When the parietal and visceral layers of peritoneum are adherent, packing will arrest bleeding; f they are not adherent, packing will only push away the movable liver (John D'Connor). If pyothorax exists, resect a rib, open the pleural sac, and reach he abscess in the liver by an incision through the diaphragmatic pleura and the liaphragm (transthoracic hepatotomy).

Rogers and Wilson ("Brit. Med. Jour.," June 16, 1906) advocate aspiration and examination of the pus. If amebæ only are present, they inject a solution of quinin, a material quickly fatal to amebæ. The dose is 30 grains of bihydrochlorate of quinin in a sterile solution. If the abscess holds less than 10 ounces of pus, the quinin is given in 2 ounces of fluid; if it holds more, in 4 ounces of fluid. The authors report 2 cases cured by this method.

Treatment of Traumatic Abscess.—Is the same as for tropical abscess.

Treatment of Pyemic Abscess.—Surgery is usually futile, because multiple abscesses exist, but an operation should be performed in the hope that it may do good. In a case in the Jefferson Hospital in which abscess of the

liver followed appendicitis the patient recovered after operation.

Hepatoptosis (Floating or Movable Liver).—Hepatoptosis may be congenital, but is usually acquired. In a congenital case certain ligamentous supports of the liver are absent. In the following discussion the acquired form is the variety referred to. This condition is rare. Ninety-eight cases have been reported.\* It is a form of splanchnoptosis and is due to relaxation of the abdominal wall and stretching of the supports of the liver. It may occur alone, but it is more often a part of a general abdominal relaxation or of Glénard's disease, and often a kidney is movable, or uterine displacement or hernia may exist. The liver may descend into the lower abdomen, may be upside down (Demarquay), may rotate on its transverse axis (Griffiths), the anterior surface may become posterior, or the organ may lie with the superior surface in the right flank and the inferior surface looking to the left,† may be movable, or may be anchored by adhesions. It is most common in women. The liver is supported by ligaments and also by the inferior vena cava, which vessel is firmly adherent to the central tendon of the diaphragm (Faure), by the abdominal wall, and by the intestines (Glénard). The cause of the condition is in dispute. It can result from relaxation of the belly-wall, relaxation of the ligaments, enteroptosis, great enlargement of the gall-bladder, ncrease in weight of the liver, atrophy of the connective tissue between the iver and diaphragm, pregnancy, the growth of a liver tumor, and tight lacing. Either a strain, cough, or the dragging of an adherent tumor may be the exciting cause.

Signs and Symptoms.—An abdominal mass may appear suddenly after a blow or a strain, and if it does appear suddenly there is always pain in

<sup>\*</sup> J. H. Carstens, Jour. Am. Med. Assoc., May 17, 1902. † Terrier and Auvray, Rev. de Chir., Aug. and Sept., 1897

the hepatic region, nausea, and weakness. When the condition comes on gradually, there may be no symptoms for a long time, but, as a rule, there is some pain in the loin which becomes worse after exercise or effort. In rare cases jaundice appears, and occasionally there is ascites. The abdominal walls are relaxed and the signs of splanchnoptosis are manifest. When the patient stands, a transverse furrow of skin covers the lower part of the umbilicus (Glénard's sign). In most cases the shape, the movability, and the absence of the liver from its proper position are diagnostic. Even when the organ is dislocated and attached in its new situation, it is missed from its proper abode, and palpation outlines the characteristic shape. When the patient lies down, the liver usually returns to place, and in most cases it can be restored by manipulation. In some cases, however, it will not return to place and cannot be restored by manipulation. A floating liver causes a recognizable enlargement in the right loin, and the mass usually moves on respiration.

Treatment.-In many cases the patient can be kept comfortable by wearing an abdominal support, and can be distinctly improved by the use of massage and electricity to the abdominal wall, the administration of tonics, and a course of forced feeding. If these means fail and the patient suffers. an operation should be performed. The operation of hepatopexy was devised by Marchant. He opens the abdomen and tries to restore the liver to its proper position. This can usually be accomplished. In some cases it can be done after adhesions have been separated. In other cases it can be only partially accomplished. After the liver has been restored, he sutures it by means of catgut or silk to the abdominal wall or costal cartilages, the stitches passing through the hepatic parenchyma and being carried through the liver by means of a round and blunt needle. The sutures attaching the liver to the belly-wall are tied beneath the skin. Marchant scarifies the dome of the liver in order to favor adhesions. Ramsay rubs the upper surface of the liver with gauze to promote adhesion and transfixes the round ligament with a suture which is carried around the cartilage of the seventh rib. In a severe case Depage advises us to associate hepatopexy with an excision of a portion of the abdominal wall to amend relaxation (laparectomy). If, in operating on a floating liver, it is found impossible to get the liver back into its normal position, fix it with sutures as near its proper abode as is possible. Terrier and Auvray report 11 cases of hepatopexy. One case died and eight completely recovered.

Floating Hepatic Lobe (Partial Hepatoptosis).—This condition is not uncommon in cases of chronic disease of the gall-bladder and is most often met in cholelithiasis. It is believed that it can be caused by tight lacing. A tongue-like projection forms upon the right lobe of the liver (linguiform lobe). It can be palpated below the costal margin and the dulness of the mass on percussion is continuous with liver-dulness. A linguiform lobe can usually be moved laterally and forward and backward;

it is always tender and is sometimes the seat of pain.

Treatment.—When this condition is associated with gall-bladder trouble, it may disappear, or at least cease to cause pain, when the gall-bladder is drained by cholecystostomy. Langenbuch has successfully removed a linguiform lobe.

Cholecystitis (Inflammation of the Gall-bladder).-Inflammation

of the gall-bladder is produced by infection. Healthy bile is sterile; and when bacteria are found in the bile, the condition is one of disease, Microorganisms may find entrance into the gall-bladder by way of the blood, the bile becoming infected secondarily to the infection of the gall-bladder; or they may enter by way of the ducts, from the intestine. The conditions that follow infection depend upon the characteristic tendency and the virulence of the infecting germs. A trivial infection produces mucous catarrh; a more active infection causes suppuration, and possibly ulceration; a very violent

infection leads to gangrene.

In most cases of cholecystitis an inflammatory swelling blocks the cystic duct, and obstructs it so that the bile stagnates in the gall-bladder. In many cases this condition lasts but a short time; and when the obstruction is relieved, bile flows down the duct. Occasionally, as a secondary consequence, cholangitis, or infection of the hepatic ducts, follows.\* Occasionally, also, the obstruction of the duct is not relieved, and a quantity of clear, thin mucus gathers in the gall-bladder and overdistends it—the condition known as hydrops. The gall-bladder may likewise become distended with Jus, constituting an empyema of the gall-bladder; and any overdistended all-bladder may rupture. A gall-bladder may distend to a most enormous = ize. Terrier reported a case of distended gall-bladder in which the viscus ontained 42 pints of fluid. F. W. Collinson ("Brit. Med. Jour.," May 29, reports the case of a woman of thirty-one years of age who was tapped wice before operation and at each tapping 25 pints of fluid were withdrawn. At the operation 22 pints were obtained. Collinson's case arose from blocking of the common duct as a result of traumatism, followed by kinking of the cystic all card subsequent opening of the common duct. In cases of very chronic Immation of the gall-bladder this structure becomes fibrous and contracts, til it may become no larger than the thumb, in which condition it may entain a very small amount of thickened bile. In some inflammatory conditions due to infection the bile mixes with thickened mucus, and microreganisms form the nucleus upon which bile salts are deposited to form 211-stones. As the same author points out, cholelithiasis may result from bolecystitis, and may cause chronic cholecystitis, because the stones existing a gall-bladder are sources of irritation.

Bacteriology of Cholecystitis.—It has been proved by abundant observation that the fact that bile contains micro-organisms is no evidence the gall-bladder is inflamed; but that when the gall-bladder is inflamed, micro-organisms are demonstrable in the bile. We know that the bile is fected during the course of typhoid fever, and that it is frequently so in preumonia. The colon bacillus is not unusually demonstrable in cholecystitis; and pus-cocci, either in pure culture or mixed with other germs, constitute the most common cause of the inflammation. It is probable that bacteria entering the gall-bladder and not being particularly virulent produce immediate harm when the flow of bile is unobstructed, though even then they may become the nuclei of gall-stones; but if the bacteria are very virulent, they may actually lead to obstruction. Stagnation of the bile favors infection, and infection may be the cause of stagnation. Each influence reacts upon the other and aggravates the other, and it seems more than

<sup>\*</sup> Joseph McFarland, Proceedings of the Phila. Co. Med. Soc., Sept., 1902.

possible that infection of the gall-bladder is to be regarded as serious only when there is obstruction to the outflow of bile. The same variety of germ may, under some circumstances, cause catarrhal, and under others suppurative, inflammation; that is, when bacteria are virulent and tissue resistance is slight, suppurative cholecystitis results; but when the bacteria are not virulent and the tissue resistance is powerful, the gall-bladder is not infected at all, or only catarrhal inflammation is produced. I operated upon a case of acute suppurative inflammation of the gall-bladder three weeks after the termination of an attack of typhoid fever. The culture taken from the gall-bladder showed an unidentified bacillus, which was not the colon bacillus or the paracolon bacillus, and which was not identical with the typhoid bacillus or the paratyphoid bacillus. It strongly resembled the typhoid bacillus, but possessed no agglutinative power (the author, in "New York Med. Jour.," April 8, 1905).

A patient in the medical ward of the Jefferson Hospital was supposed to be developing a typhoid relapse, but no fresh spots appeared, and there were pain, tenderness, and rigidity in the region of the gall-bladder. I operated and found the gall-bladder full, dark-colored, and surrounded by numerous recent adhesions. It could be emptied slowly by pressure. There was no pus. It was drained and the symptoms promptly passed away and the man recovered. The culture was reported sterile. I cannot understand this finding, as inflammation undoubtedly existed. It may have been peritonitis rather than cholecystitis, but from what cause is unknown. No culture was taken from the peritoneal cavity. The finding of sterile bile

at the end of an attack of undoubted typhoid is of interest.

Catarrhal Inflammation of the Gall-bladder and Bile-ducts. -This condition is known as catarrhal jaundice, acute or chronic, and is usually treated by the physician; but, as A. W. Mayo Robson points out, chronic catarrhal jaundice sometimes resembles the jaundice of organic disease, and is occasionally associated with gall-stones, malignant disease, or hydatid cyst. The same authority asserts his belief that chronic catarrhal jaundice usually results from interstitial pancreatitis and duct obstruction. This condition usually comes on without pain. If there is pain it means some complication. Robson ("Surg., Gynecol., and Obstet.," Jan., 1908) names among such complications catarrhal cholecystitis, cholangitis, gall-stone, and duodenal ulcer. The jaundice is striking. There is loss of flesh and anemia, and the liver is enlarged and smooth. Robson tells us that if the gallbladder is not shrunken from stone, and if there is great duct obstruction, the bladder will be distended. Chills and fever mean infective cholangitis. In a case of chronic catarrhal jaundice in which medical treatment fails, surgical treatment must be considered (cholecystostomy or cholecystenterostomy).

Catarrhal Cholecystitis.—This is a catarrhal inflammation of the gall-bladder usually without jaundice. The gall-bladder becomes thick and its mucous membrane is frequently plicated. Very thick mucus is secreted, which gathers in masses, and the descent of these plugs causes pain that is sometimes indistinguishable from that produced by the passage of a gall-stone. Such a plug may temporarily block the cystic duct. In catarrhal cholecystitis the gall-bladder is frequently distended, but rarely admits of palpation; and there are no adhesions to surrounding structures, unless

gall-stones have been present (Robson). Catarrhal cholecystitis may lead to the formation of gall-stones; may result from the presence of gall-stones; or may be found in cases in which gall-stones have been present, but have passed. In one case upon which I operated the gall-bladder was enlarged, thick, and without adhesions; the mucous membrane was convoluted; and the viscus was filled with thick, tenacious mucus, and the mucous membrane of the gall-bladder contained many minute concretions. In this case stoneformation was probably beginning to follow upon catarrhal cholecystitis. In another case a woman had presented violent symptoms of gall-stone colic, and stones had been recovered from the feces; but on opening the gallbladder no stones were found—only a condition of catarrhal cholecystitis. Taundice is rare in catarrhal cholecystitis unless gall-stones are present; it is, however, occasionally noted. Even if jaundice does occur, it is slight and lasts but a short time. The painful attacks that occur during catarrhal holecystitis are similar to gall-stone attacks; but the pain is less violent and of briefer duration, and jaundice is not apt to follow the passage of a plug of ucus and is apt to follow the passage of a gall-stone. Further, as Robson has shown, in cholecystitis with gall-stones there is usually tenderness on pressure over the gall-bladder; and there is rarely tenderness in uncomplicated catarrhal cholecystitis.

Treatment.—The majority of the cases recover under medical treatment.

If a case fails to recover under medical treatment, one cannot be sure whether there are gall-stones or not; but an operation is indicated in either case.

Cholecystostomy should be performed, and the gall-bladder should be drained for a week or two. This treatment will almost always produce cure.

Croupous Inflammation of the Gall-bladder and the Bile-ducts.—This is an extremely rare condition, due to the formation of a thick membrane in the bile-passages, which causes obstruction to the flow of bile and spasmodic contraction of the gall-bladder. The symptoms are identical with those of gall-stones. Robson points out that a study of the evacuations may discover membranous intestinal casts; and that, as membranous enteritis is, usually associated with croupous inflammation of the sall-bladder and bile-ducts, a diagnosis may thus be reached. The same author says that one may, in some cases, even find a cast of the gall-bladder in the evacuations.

Treatment.—If medical treatment fails, cholecystostomy should be performed and drainage should be employed for a considerable time.

Suppurative Inflammation of the Gall-bladder and Bile-ducts.—
Adopting the classification of Mr. Robson, we divide these suppurative inflammations into simple suppurative cholecystitis, suppurative and infective cholangitis, phlegmonous cholecystitis and gangrene of the gall-bladder, ulceration of the gall-bladder and bile-ducts, pericystic abscess with adhesions, and certain consequences of these conditions, such as stricture of the gall-bladder and bile-ducts, perforation of the gall-bladder and bile-ducts. Suppurative inflammations of the gall-bladder and the bile-passages are due to infection with virulent organisms or to infection when the tissue resistance is at a low ebb.

One fact must strike the physician in regard to these cases; that is, that

there is a strong similarity between the possible changes of acute cholecystitis and the possible changes of acute appendicitis. In the gall-bladder, as in the appendix, there may be a catarrhal inflammation, which may not advance beyond this stage, or which may advance into a more dangerous form; in each structure, blocking and stagnation favor infection and aggravate existing infection; in each there may be suppuration, ulceration, gangrene, and perforation; in each there may be grave complications and disastrous and fatal consequences; and in each prompt surgical operation is usually life-

saving.\*

Simple Suppurative Cholecystitis.—This condition is also spoken of as suppurative catarrh of the gall-bladder or simple empyema of the gall-bladder. It is a rare condition, unless gall-stones exist, or unless some infectious disease—especially typhoid fever—has antedated the condition. I operated for this condition upon a boy of eleven years of age three weeks after the termination of an attack of typhoid fever. It is not only typhoid fever that may be causative, but also other continued fevers. No matter, however, what organism is primarily responsible,—be it colon bacillus, typhoid bacillus, or what not,—a mixed infection with pyogenic cocci usually takes place. Pyogenic cocci may alone be causative. In simple suppurative catarrh of the gall-bladder when the duct becomes blocked, the condition known as simple empyema exists; and when hydrops of the gall-bladder undergoes suppuration, simple empyema is produced.

In an ordinary case of suppurative catarrh following gall-stones one usually obtains the history of a number of attacks of biliary colic, the pain finally having become persistent, instead of intermittent; and a definite swelling being palpable in the gall-bladder region. This swelling is tender on pressure. There are usually constitutional symptoms, sometimes trivial, often severe. The trivial symptoms are a somewhat rapid pulse, sweating at night, and some elevation of temperature. The more severe symptoms are chills, a remittent fever, and profuse sweats. The development of severe symptoms indicates that a dangerous change is taking place—usually ulceration of the gall-bladder, occasionally phlegmonous cholecystitis. Distinct jaundice is rare in simple empyema, though the patient usually shows loss of flesh, has a very poor appetite, and suffers considerably from thirst.

To distinguish an enlarged gall-bladder from any other intra-abdominal mass is sometimes difficult. Very large gall-bladders, such as have been placed on record by Collinson, Terrier, Lawson Tait, Gersuny, and others, may be mistaken for ovarian cysts. Alban Doran discusses such cases in the "Brit. Med. Jour.," June 17, 1905. An enlarged gall-bladder moves on respiration, unless the mass becomes adherent to the abdominal walls, when it will cease to do so. An enlarged gall-bladder is sometimes mistaken for a movable kidney, and the diagnosis between these conditions is discussed in the section on Movable Kidney (page 1275).

Treatment.—The gall-bladder should be opened and drained by the operation of cholecystostomy. After it has been exposed, it is packed about with gauze pads, a considerable amount of the contents is removed through an aspirator, the gall-bladder is opened and irrigated with salt solution, and a search is made for any cause of obstruction in the cystic duct. This

<sup>\*</sup> The author, Proceedings of the Phila. Co. Med. Soc., Sept., 1902.

cause should be removed, and any gall-stones that are present should, of course, be taken away. The walls of the gall-bladder will frequently be found diseased and softened, so that it is impossible to apply stitches. In some cases, if the gall-bladder is badly diseased, it should be removed; but in others, incision with drainage is sufficient.

Recurrent Simple Empyema of the Gall-bladder.—In this condition a person develops, at intervals, pain, fever, tenderness, and enlargement of the gall-bladder. Then the symptoms clear up and he is well for a time, but they again become manifest; and at last they may become persis-



Fig. 528.—Gall-bladder removed by cholecystectomy for calculus, empyema, and gangrene.

the gall-bladder; and when an operation is performed, the gall-bladder is shrunken, thickened, and deeply placed, containing some purulent atter, and strongly fixed to the surrounding structures by adhesions.

Treatment.—Cholecystectomy is usually the proper operation.

Acute Phlegmonous Cholecystitis.—Some call this condition acute yema. It is extremely dangerous, and is apt to cause gangrene of the bladder. It is due to infection with extremely virulent organisms. The produce rapid peritonitis and death without perforation, but oftener foration takes place. It is generally associated with the presence of calculi, sometimes none are found; and the condition sometimes develops during phoid fever or septicemia.

This disease begins with sudden and violent pain in the gall-bladder region. This pain usually radiates toward the right shoulder-blade, and becomes general throughout the abdomen. There are tenderness in and rigidity over the gall-bladder region, thoracic respiration, exhausting remitting, septic fever, and in some cases jaundice. If an operation is not promptly performed, general peritonitis quickly takes the patient's life. In one case upon which I operated there were intense jaundice, tenderness, violent pain, abdominal rigidity and distention, chills, and septic fever; and when the abdomen was opened, it was found that a portion of the gall-bladder was gangrenous and that a calculus projected through the gangrenous opening.

It is this form of cholecystitis that is especially likely for appendicitis. In making a diagnosis the situation of is of importance, and likewise the situation of the tenders placed gall-bladder or an abnormally situated appendix wi Acute phlegmonous cholecystitis is usually accompanied by stipation, and the sudden onset and the abdominal distent the disease being mistaken for intestinal obstruction. It m fused with perforating ulcer of the stomach or of the duodenu

Treatment.-In any case of doubt an exploratory inc made. If phlegmonous cholecystitis is found to exist, the gall whenever possible, be extirpated; but if the desperate condition forbids this operation, it should be surrounded with iodofo drainage-tube should be carried well up toward the cystic due

Pericystic Abscess.-Pericystic abscess may follow gall-bladder. It is especially common in the condition kno simple empyema. When a pericystic abscess exists, there ar abdominal tenderness and rigidity and the temperature is u of suppuration. The causative micro-organisms may have diseased gall-bladder wall, rupture not existing; or the abs ulceration or perforation of the gall-bladder wall.

Treatment.-Operation should invariably be performed frequently difficult. After a pericystic abscess has been be found necessary in some cases to extirpate the gall-blac others, cholecystostomy and drainage will prove sufficient.

Suppurative and Infective Cholangitis.—The infective cholangitis is gall-stones lodged in the common d those cases in which a gall-stone acts as a ball-valve. A. W though he believes that infective cholangitis does occur whe are freely movable in the common duct, sets it forth as his it is much more common in such cases to find gall-stones common duct.

In such cases the patient gives a history of attacks of without jaundice for several years, and then of attacks following rary jaundice (page 1033). Finally comes an attack that is fo and fever; and jaundice, varying in intensity, ensues upon this, it may fade, it seldom completely disappears between the Robson points out that the interval between the attacks may and that the rigors may be repeated daily or at uncertain int gall-bladder is usually, but not always, contracted; and that tion has persisted for some time, the liver becomes distinctly e are tenderness over the gall-bladder or in the epigastric regiand persistent jaundice which may vary in hue.

Infective cholangitis, even after it has lasted for a con of time, may be recovered from; but it may pass on into an in which poisoning takes place from the biliary elements, s langitis may arise, an empyema of the gall-bladder may de may be an abscess of the liver or some other dangerous or fat The ague-like attacks of infective cholangitis have been ca

intermittent hepatic fever (page 1034).

Treatment.—After an incision has been made, the duct is opened and e cause removed; but, as Mr. Robson points out, the complication should be ticipated. When one finds that carefully applied medical treatment has led to free the patient from gall-stones, they should be removed surgically. Suppurative Cholangitis.—Suppurative cholangitis is usually a delopment of the ordinary infective cholangitis, which has just been discussed. nong the other causes that Robson sums up are acute infectious diseases, rticularly typhoid fever and influenza; cancer of the bile-ducts; and datid disease.

In this condition the liver enlarges notably and becomes tender. In me cases there is an empyema of the gall-bladder, but this is rare; in fact, e gall-bladder is usually very much shrunken. When, in a chronic case, ere are enlargement of the liver, blocking of the common duct, and enlargement of the gall-bladder, the inference is in favor of cancerous obstruction the common duct. If the obstruction is due to cancer, there will usually little pain; but when it is due to gall-stones, there will be violent attacks pain, accompanied by rigors and fever, with deepening of the jaundice. this disease there is always jaundice, usually unfading; but in cases of Ll-valve gall-stone in the duct it will be mitigated from time to time (page \$4). The patient suffers with septic fever and very rapid loss of flesh.

The condition is generally fatal, unless operation is performed early. ere is a strong tendency for abscess of the liver to form, and in one case on which I operated a subphrenic abscess had developed.

Treatment.—Cholecystostomy with free and prolonged drainage. If an cess of the liver exists, it should also be drained. If gall-stones are gather in the common duct, they should, be removed.

Typhoid Cholecystitis.—As previously stated, typhoid bacilli are tally present in the bile during, and perhaps are present months or years er, an attack of typhoid fever. They are not always present, however, in a case of cholecystitis following typhoid on which I operated an unidened bacillus was found ("New York Med. Jour.," April 8, 1905); in a se on which I had made an artificial anus for typhoid perforation and subquently performed intestinal resection I drained a greatly distended galladder at the second operation and cultures of the bile remained sterile; ad in a case of typhoid with distended and apparently inflamed gall-bladder which I operated the bile was reported to be sterile. Because typhoid acilli are usually present in the bile during typhoid does not mean that ost cases of typhoid have cholecystitis; cholecystitis is not very common, ad arises when bacilli are very numerous or very virulent, when vital resisnce is lowered, when there is antecedent inflammation of the gall-bladder, hen there are gall-stones, and particularly if there is a block of the duct using stagnation of bile. Bacilli then may do no harm at all, but they may use a catarrh, a purulent catarrh, suppuration of the gall-bladder walls, ppuration outside of the gall-bladder, or perforation. When bile or inflamatory exudate contains typhoid bacilli, agglutinins are present and may ecipitate masses which become nuclei for gall-stones.

The most usual period for cholecystitis to arise is during the third week the fever, but it is not uncommonly met with during convalescence and is rhaps mistaken for a relapse.

The condition may arise months or a year after the attack of typhoid, ar yet a pure culture of typhoid bacilli may be obtained from the gall-bladde Strange to say, cases of cholecystitis have been operated on in persons givin no history of having had typhoid, and typhoid bacilli have been obtaine from the gall-bladder. Such a person may have had a very mild attack = typhoid, or he may be immune to typhoid fever and yet the bacillus may be capable of causing inflammation. Many cases of typhoid cholecystitis ar probably unrecognized because of the trivial symptoms, or because a hig position of the liver renders the real seat of pain obscure, because the general symptoms are uncertain, because toxemia blurs perception of pain, or because the condition is confused with appendicitis. It is rare in children, mor common in adults. Most infections result from the bacilli ascending the common duct, some are by way of the lymphatics (Charles H. Mayo), somby an adhesion of the gall-bladder to the bowel, some by way of the porta circulation and the bile-ducts. Mixed infection may occur, and a secondary staphylococcus infection may be followed by disappearance of the typhoiobacilli. The symptoms of typhoid cholecystitis are pain and tenderness in the gall-bladder region, rigidity of the upper half of the right rectus muscle perhaps a palpable mass, an elevated and remittent temperature, sweats perhaps jaundice, and sometimes leukocytosis. In some cases perforations occurs. Erdmann reported 1 case and collected 34 from literature ("Annal= of Surg.," June, 1903).

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In an ordinary case without perforation incise and drain the gall-bladder If perforation exists, do cholecystectomy if possible; if not, drain. No attempt should be made to suture the perforation. If perforation exists an operation is not done, death is practically certain. Of 27 cases not operated

upon, all died; of 7 cases operated upon, 4 recovered (Erdmann).

Gall-stones.—Gall-stones are formed during life in the gall-bladde or bife-ducts by the agglutination of materials which have precipitated from bile. The nucleus of a gall-stone may be a mass of bacteria, a blood-closed epithelium, crystals of cholesterin or carbonate of lime, or a cast of a small duct.\* A condition of the body thought to lead to the formation of galacteristics. stones is designated by the term cholelithiasis (Brockbank). But one store may be present or great numbers may exist. Solitary stones may be near round or cylindrical. When several stones or many stones exist, the mutt pressure often leads to the formation of facets (Naunyn). In color, calc may be pale yellow, green, black, or brown. Some are heavier than \ and some are lighter. Brockbank gives the following varieties of gall-story pure cholesterin stones, stratified cholesterin stones, common or gall-blad calculi, mixed bilirubin-calcium calculi, pure bilirubin-calcium calculi, certain rare forms. † Gall-stones usually take origin in the gall-bladder may arise in the common duct, the cystic duct, the hepatic duct, or the sm = ducts of the liver. As a rule, however, calculi in the common or cystic duct not formed there, but were transported from the gall-bladder or hepatic de-

Causes.-Gall-stones are very commonly found postmortem. Germany it is estimated that they are found in 12 per cent. of all cases. 1655 autopsies in the Johns Hopkins Hospital gall-stones were present

<sup>\*</sup> Bevan, in Chicago Med. Recorder, April, 1898. † Brockbank's treatise on "Gall-stones."

6.94 per cent. of all cases.\* The usual estimate is 5 per cent. of autopsies. The cause is a catarrhal condition of the bile-ducts, due particularly to the entrance of bacteria from the intestine (colon bacilli, typhoid bacilli, pusprganisms, pneumococci). This catarrhal condition causes stagnation of bile. Healthy bile is sterile, but not germicidal, and bacteria will grow in it. Bacteria have been found in bile years after the termination of an attack of yphoid fever. Experimental infection of the gall-bladder producing mild holecystitis is almost always followed by gall-stone formation.† Welch pointed out that recent gall-stones have bacteria in their center. Cushing tells as that 30 per cent. of gall-stone cases operated upon in the Johns Hopkins Hospital had previously suffered from typhoid fever, but Mayo's experience a not in accord with this view. In view of the fact that bile containing typhoid acilli must contain agglutinins we can understand how masses could be pre-ipitated to form nuclei. Thirty per cent. of Ochsner's cases had had appendititis.

The chief predisposing causes are advancing years, insufficient exercise, ne daily consumption of unnecessarily large quantities of food, gouty tendenes, conditions which interfere with the emptying of the gall-bladder, cardiac isease, and cancer of the liver. Gall-stones rarely form before the age of nirty-five. The youngest patient I ever removed stones from was a girl f twenty. The disease is more common in the insane than in the mentally ound, in the white race than in the black, and in women than in men. In per cent. of all females beyond sixty years of age gall-stones are present Naunyn). The special liability of woman may be brought about by tight cing, pregnancy, inactivity, or movable right kidney. Stout and lazy women e particularly liable to gall-stone formation and women who have born aildren are far more liable than those who have not. Total abstainers seem possess a greater predisposition than users of alcohol, probably because they e more apt to be large eaters (Herbert F. Waterhouse, in "Lancet," May 8, (200). There are two forms of the condition to be considered: the acute type, ie to efforts made by the gall-bladder or duct to expel the concretion; and the pronic condition, in which a calculus is lodged for a long time, or in which, soon as one calculus is passed into the intestine, "another begins its journey" Brockbank). The fact that bacteria cause the condition must not lead us to ifer that pus is of necessity formed. The bacteria are present in small numers, or else their virulence is greatly mitigated; they produce only catarrhal iflammation, the bile stagnates, and a stone forms. There may be one tone, two stones, several, or many stones. I have removed 200 from a atient. Multiple stones are facetted. Solitary stones are not facetted.

Many observers believe that inflammation of the mucous membrane causes be secretion of quantities of cholesterin, which material forms a large part f most gall-stones. Others maintain that cholesterin is a normal constituent f bile and is not obtained from the mucous membrane.

Bachmeister ("Münch. Med. Woch.," Feb. 18, 1908) demonstrates that pure sterile bile is permitted to stand for a considerable time cholesterin ill be precipitated, and that if epithelial cells are added to this the cholesterin precipitated much more rapidly. The catarrhal inflammation furnishes

<sup>\*</sup>C. D. Mosher, in Johns Hopkins Hosp. Bull., Aug., 1901. †Gilbert, in Archives générales de méd., Aug. and Sept., 1898.

quantities of epithelial cells and the cells precipitate cholesterin, and in this way inflammation causes gall-stones. It is probable that when gall-stones exist they are all due to a common cause and all began to form at the same time. It is not likely that one begins and then another, and so on. After a stone once begins it may progressively increase in size. In many cases the stone or stones never cause trouble. A gall-stone may begin to descend because of violent muscular exertion, external pressure, or at the onset of a fresh inflammation which leads to loosening of the stone. A very small stone usually passes freely. A larger stone in passing causes colic. A still larger stone remains in the gall-bladder, or becomes fixed in the cystic duct or the intestinal outlet of the common duct. In most cases gall-stones form in the gall-bladder. In some they form in the common duct if stones have previously existed in the gall-bladder. When the common duct retains a stone and is suffering from some degree of obstruction and from infection, stones may form in the hepatic ducts (Wm. J. and Chas. H. Mayo, in "Am. Jour. Med. Sciences," March, 1905). Stones are occasionally found at necropsy in the radicles of the hepatic duct.

Symptoms.—The formation of a stone requires several months, and during the antecedent period of gastro-intestinal catarrh, "the prodromal state" of Kraus, certain symptoms may exist, viz.; constipation, flatulence. loss of appetite, migraine, uneasy sensations in the epigastrium or right hypochondrium, sallowness of the skin, slight yellowness of the conjunctiva; scantiness of urine, which excretion is saturated with uric acid, and may after a time contain a little bile. If this condition is not arrested by treatment, it = grows worse. The abdomen becomes decidedly distended; pressure over the stomach or liver may cause distinct uneasiness or even pain; acid indigestion is very troublesome; violent attacks of migraine occur; constipation becomemore decided, the feces become clay colored, gastralgia may occur, the skin is apt to be slightly jaundiced, itching is complained of, the patient is irritable and sleeps poorly. The liver is found to be enlarged, and the urine contains distinct amounts of bile. When the patient reaches this stage, gall-stones are very liable to form. These symptoms may pass away even if a concretion on forms. It is quite true that in some cases a stone exists for years without causing trouble. This is particularly true in elderly people. Often it causes unrecognized symptoms and seldom does it fail to cause some symptoms. In many cases the symptoms which stones cause are thought to be due to defisease of the stomach (indigestion, flatulence, pain after eating, pyloric spa = -m, etc.).

As Waterhouse says (Ibid.), the symptoms do not bear any relation to size or the number of the stones. In fact, gall-stones give rise to active symptoms only when infection occurs or when the ducts become occluded and centre to drain, or when a stone starts to pass. If infection occurs, it may pass aw spontaneously, but seldom does so. When a stone forms, pain is apt to become a marked feature of the case. John B. Murphy ("Med. News," Nov. 1903) points out that in a person with stones in the gall-bladder there may be

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The pain of acute inflammation, the result of a severe infection.
 this condition there are abdominal rigidity and contracted gall-bladder.

The pain of tension. In this there is not persistent abdominal rigidit but pressure always causes sudden and transient tension of the belly muscle Murphy's method of demonstrating tenderness of the gall-bladder is most valuable, and I always use it. It is as follows: Hook the fingers well up under the liver and tell the patient to take a deep inspiration. On inspiration pain

becomes acute and respiration suddenly ceases.

3. Referred pain, which may exist with either of the above conditions. Colic is spasmodic pain, and means that a stone has left or is trying to leave the gall-bladder, and is in or is trying to enter a duct. Many persons with a stone or with stones in the gall-bladder never have colic. A sense of pressure or of soreness in the hepatic region, the result of cholecystitis, has added to it sudden and transient paroxysms of pain, due to the passage of thick bile from the gall-bladder and small ducts, or of gravel from the small ducts, urged on by pile pressure. When a stone begins to pass from the gall-bladder, violent colic s experienced. Such a colic usually comes on very suddenly, and often about hree hours after a meal. It may, however, come on gradually, the patient omplaining greatly of flatulence. In some cases it is so sudden and violent s to simulate perforation of the stomach or duodenum. The reason colic = particularly apt to come several hours after a heavy meal is that at that time ile is passing down into the intestine. A bladder containing calculi often >lerates the presence of the foreign bodies for an indefinite length of time, and en suddenly resents their presence and ejects them forcibly or tries to eject em. The pains are violent, spasmodic, and paroxysmal, and over the hepatic and epigastric regions, "radiating upward over the right half of the thorax" raus), and passing particularly from the epigastrium to the right shoulderade. The patient is profoundly nauseated and usually vomits, the abdomen distended, and a condition almost of collapse is soon reached. The temperare is usually normal, or subnormal, but is occasionally somewhat elevated. be patient may shiver and sweating may follow, but rigors are rare. The spirations are shallow, the patient groans, cries out, flings himself about in and often, in seeking for relief, assumes some strange or contorted posin. He frequently holds one hand over the liver region. His expression is dicative of intense suffering and apprehension and sometimes of abject terror. be pain is one of the most awful a human being can feel and women who have It it assert that the pains of parturition are trivial in comparison. The attack sts a variable time, and terminates by the stone passing into the intestine or Hing back into the bladder. The usual duration of an attack is from four twenty hours. I have seen attacks that lasted three days, four days, or even ve days, almost without intermission. It terminates suddenly if the stone asses or falls back in the gall-bladder. In many cases at the termination of e attack an enormous amount of clear pale urine is passed. During and for a me after the attack the gall-bladder may be very tender. After the cessation of lic, if the feces are examined carefully during several days, the stone may be scovered. The fact that no stone is discovered does not prove that no stone as passed, because a cholesterin stone may be destroyed in the intestinal canal. the stone is passed, jaundice almost invariably follows the colic in from venty to thirty-six hours and lasts several days. The jaundice results from estone being in the common duct. If stones do not pass from the cystic act so as to enter or protrude into the common duct, jaundice does not occur. 80 per cent. of my cases (excluding common duct cases) there was no history jaundice. Even when a stone is lodged in the common duct jaundice may

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be slight or absent. When jaundice arises after a colic, it comes on gradua bile appears in the urine, and often, but not always, the stools become c colored from absence of bile. Jaundice may be first noticeable in the urine in the conjunctiva. The skin is apt to itch annoyingly, even atrociously. T patient is constipated and very thirsty. The liver is enlarged and tender a the spleen is enlarged. Some writers state that the pulse is slow in jaundie My experience is in agreement with the much larger experience of Moyniha who says: "I have not found any reduction in the pulse-rate in jaundi unless a degree of chronic pancreatitis is present" ("Gall-stones and The Surgical Treatment"). If the stone is impacted, after a time the pains be come less violent, and may entirely cease. If it ceases and the stone does no move, pain does not recur; if the stone moves pains recur, and, usually, agaand again the patient suffers from aggravation of them. An individual may g about with impacted stone, but again and again fierce attacks of colic occur and if the stone is wedged immovably in the common duct, producing absoluobstruction, the patient becomes and remains deeply jaundiced. Continue deep jaundice is seldom seen when stones are lodged in the common duct, be cause they are seldom absolutely fixed and hence seldom produce complex obstruction. Usually the stone moves from time to time or is at least lifted so that bile gets by it at intervals. This condition constitutes the "ball-valve stone, and in it jaundice, though present more or less, is at times much mor intense than at other times. It is a jaundice in which the hue is yellow, no deep brown, and it is a jaundice that wanes and deepens. It deepens after each colic and later wanes, but seldom entirely disappears while the stonremains in the duct.

In persistent jaundice due to gall-stones the gall-bladder is seldom en larged. Courvoisier showed that when persistent jaundice is associated with enlargement of the gall-bladder the cause is usually pressure on the duct from without (malignant disease of the pancreas).

Slight jaundice is not always easy of recognition. Recognition is particularly difficult in sallow individuals and by artificial light. Moynihan praises Hamel's test for slight jaundice. It is made by drawing a little blood from a puncture of the lobe of the ear into a capillary tube and permitting the tube to stand for a few hours. If any jaundice is present the serum, which collection in the upper part of the tube, will be yellow ("Gall-stones and Their Surgical Treatment").

In certain cases when a stone is in the common duct an attack of colic followed by or accompanied by a chill or chills, which may be very viole and moderate, or slight, and by a febrile seizure resembling malaria and call hepatic fever, or Charcot's fever. The temperature rises rapidly, and in an head becomes 104° F, or more, remains high for several hours, and then drops denly to normal. It may remain normal for a few hours, a day, two days, eral days, or weeks. In this condition there are jaundice and tenderne the liver. Charcot's fever is brief in duration. It usually means stone in the liver. Charcot's fever is brief in duration. It usually means stone in the slightly elevated temperature. These intermissions distinguish Charfever from the remittent fever of sepsis, and the absence of the plasmo in the blood and the history of colic distinguish it from malaria. The is due to intoxication with ptomains from infected bile retained in the

by obstruction. The condition is ominous because it is due to infection, and means inflammation of the duct (cholangitis).

The chart of Charcot's fever shows sudden elevations, precipitate descents, and complete intermissions. Moynihan calls it the "steeple chart" ("Gallstones and Their Surgical Treatment"). When infection spreads widely in the smaller intrahepatic ducts, the temperature is high and does not remit. Continuous fever of this type has usually been preceded by Charcot's fever.

If a stone lodges in the cystic duct, it does not cause jaundice unless an end of the stone projects into the common duct. It grows in size from incrustation, prevents the entrance of bile into the gall-bladder, and the bladder may shrivel and thicken or become filled with mucus, the bile being absorbed (hydrops of the gall-bladder). If a bladder so blocked becomes infected, pus forms, and the condition known as empyema of the gall-bladder exists. An empyema of the gall-bladder may rupture into the bowel, the peritoneal cavity, or even through the skin.

The common duct is involved in 1 out of 5 or 6 cases of gall-stone disease.\* Brewer points out that in 67 per cent. of cases the stone is in the duodemal extremity, in 15 per cent, in the hepatic extremity, and in 18 per cent, in the middle. If a stone blocks the common duct, jaundice always exists and persists. Blocking may be complete and the stone may ulcerate into the bowel or the peritoneal cavity. Blocking may be incomplete, the stone acting as a ball-valve and producing intermittent colic and jaundice, which waves and deepens (page 1034). Fenger points out that if a stone remains fixed in the common duct, the liver becomes tender and enlarged; but if a stone floats about in the common duct, the gall-bladder undergoes atrophy. In complete Obstruction the stools become clay colored and bilirubin is found in the urine. Fluctuating jaundice, with attacks of pain and fever, and a shrunken gallbladder are strongly suggestive of a "ball-valve" stone in the common duct. Persistent deepening, painless jaundice, the color of the skin becoming brown or even mahogany, associated with a distended gall-bladder, is strongly sug-Restive of malignant disease compressing the common duct. The above statements constitute Courvoisier's law. It is found true in 90 per cent. of cases. We may add that a persistent jaundice of yellow hue, varying somewhat, and associated with pain or with actual colic, suggests blocking of the duct by an immovable stone.

Gall-stones may lead to suppurative inflammation of the gall-bladder or bile-passages, ulceration, occlusion of the neck of the gall-bladder, dilatation of the stomach from the formation of adhesions which kink the pylorus, abscess, peritonitis, empyema of the gall-bladder, and cancer of the gall-bladder. In cancer of the ducts gall-stones are seldom found, at least are seldom found in the ducts. Eddes collected 22 cases of cancer of the papilla. In 3 of these cases there were stones in the gall-bladder, in 1 there was a stone in the common duct ("Boston Med. and Surg. Jour.," March 7, 1901). If the Patient develops distinct infection of the gall-bladder or bile-ducts, he will suffer from chills, fever, and sweats.

Gall-stones may lead to cirrhosis of the liver. A stone may ulcerate into the bowel and cause intestinal obstruction. It may be difficult to make diagnosis between gall-stones with icterus and cirrhosis of the liver with

<sup>\*</sup>Robson, in Lancet, April 12, 1902.

icterus. In the former case the urine contains bilirubin and in the la

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Treatment.—In the prodromal stage and after recovery from an attainsist on the patient taking considerable outdoor exercise. Direct him take a cold sponge-bath every morning, to move the bowels freely every day, and to employ a simple diet. He should avoid all highly season foods, pastry, rich soups, fatty food, cheese, alcohol, and sweets. Alkalinternally are of value.

During a colic give an enema, apply hot turpentine stupes over the hepatic region, and administer hypodermatic injections of morphin attropin. If vomiting does not occur, let the patient drink a large amount of warm water to favor it. After the attack administer a purgative.

When the attack has terminated, examine carefully for any evidence

inflammatory trouble in the hepatic region.

In certain cases operation becomes necessary. Mr. A. W. Mayo Robson advises operation in the following cases:\* in frequently recurring biliary coliwithout jaundice, whether the gall-bladder is enlarged or not; in cases enlargement of the gall-bladder without jaundice, even if there is no pairs in persistent jaundice which was ushered in by pain, painful seizures occur ring, whether or not febrile attacks occur; in empyema of the gall-bladder in peritonitis beginning in the gall-bladder region; in intrahepatic abscess and in abscess about the liver, gall-bladder, or bile-ducts; in some cases where the stones have been passed, but adhesions remain and produce pain; imfistula cases; in some cases of persistent jaundice due to obstruction of the common duct, although there may be a possibility of cancer existing; in phlegmonous cholecystitis and gangrene of the gall-bladder. Besides these conditions, which may be produced by gall-stones, Robson operates for wound of the gall-bladder, infective and suppurative cholangitis, and for some con ditions of chronic catarrh of the bile-ducts and gall-bladder. † The tendence to operate early for gall-stones is growing. It is true that stones may causno trouble, but sooner or later they are apt to, there is no tendency whateve to spontaneous cure, and medicine cannot dissolve them in the bladde-Early operations are easy and comparatively safe; late operations are difficure and dangerous, and by early operation dangerous complications (infectio adhesions, obstructive jaundice) are avoided. As Maurice H. Richardson says: An early operation is less dangerous than the passage of a stone; com plications are avoided or lessened; even if the diagnosis is wrong, the condition may be found and removed. If obstructive jaundice exists, opetion is dangerous because of the possibility of fatal oozing of blood.

The common operation is cholecystostomy, which consists in opening gall-bladder, removing the stones, and making a temporary fistula in the bladder. The fistula is permitted to heal, after a time, hence many it cholecystotomy rather than cholecystostomy. Operation should be depromptly and should not be delayed. To delay permits the gall-bladder thicken and shrink, and allows the stone to enter the duct. After drainage gestones rarely reform. Wm. J. Mayo collected 2000 operations done by six

Boston Med. and Surg. Jour., Sept. 5, 1901.

<sup>\*</sup>Mayo Robson on the "Gall-bladder and Bile-ducts."

<sup>†</sup>Robson's treatise, from which the above is taken, is a valuable exposition of surgery of the gall-bladder and bile-ducts.

geons, and in not 1 case did stones reform. Kocher has seen stones recur in cases out of 31 cases of cholelithiasis after ideal cholecystotomy (suturing all-bladder after removing stones), in 1 case out of 10 cholecystostomies, and a r case out of 30 cholecystectomies. The operation of incision, removal of he stone, and suture of the gall-bladder is known as ideal cholecystolomy or holecystendysis. If calculi exist in the common duct, it may be possible, after eliotomy, to manipulate them back into the bladder and extract them from nat viscus with a scoop, but this maneuver is impossible unless the cystic duct dilated. In some cases the gall-bladder is incised, a fistula is made, and the uct and bladder are frequently irrigated. In other cases the stone may be rushed by the fingers manipulating the duct and the concretion within it holedocholithotrity). Robson points out that crushing of the stone is apt leave fragments which may cause trouble, and it should be done only when ie stones are soft. It is wrong to endeavor to force a stone from the common act into the duodenum. The attempt will fail, and in some cases the patient ill be placed in a worse condition by the stone lodging in Vater's diverticum.\* The duct may be opened, and after the removal of the stone closed v sutures (choledochotomy) or drained for a time (choledochostomy), strands gauze being carried down to the opening and in some cases a tube being rried up a dilated duct toward the liver. If the stone is impacted near the atlet of the duct, it may be necessary to incise the duodenum in order to reove the stone (duodenocholedochotomy). A dilated bile-duct may be anastoosed to the bowel (choledocho-enterostomy) or to the surface (choledochostomy). he obstruction may be side-tracked by anastomosing the gall-bladder to the owel (cholecystenterostomy) (p. 1116). Cholecystenterostomy affords drainage, at does not remove the cause of trouble, and infection is apt to be received from e bowel. In some rare cases of common duct obstruction, in which the galladder is distended and the condition of the patient is desperate, anastomose e gall-bladder to the colon (Robson). In some cases of diseased gall-bladder e viscus is removed (cholecystectomy). Cysticotomy is incision of the cystic ect. Wm. J. Mayo and others have pointed out that a danger in operations on e common duct is a sudden fall in blood-pressure when the duct is being anipulated. All operators have observed it. Ransohoff maintains that it ses only when the portal vein is compressed.

Carcinoma of the Gall-bladder.—In 405 operations on the gall-adder and biliary passages the Mayo brothers found malignant disease times (5 per cent. of cases). (See Wm. J. Mayo, in "Med. News," Dec. 1902.) Malignant disease may be primary or secondary. In primary carcoma calculi are always present, and are apparently causative by maintaining pronic irritation. Stones are seldom present in secondary malignant disease.

Carcinoma of the gall-bladder can usually be palpated. It is hard and dular, and seldom accompanied by much abdominal rigidity. There will a long history of attacks of gall-stone colic and of recent or comparatively cent grave loss of flesh. Sooner or later jaundice arises, deepens, and persists.

Cholecystectomy has been employed for this condition, but offers but the hope. In 2 cases in which I opened the abdomen without suspecting alignant disease of the gall-bladder the liver was hopelessly involved. In case in which I operated for a supposed impacted stone in the common duct an operable cancer of the common duct was found.

<sup>\*</sup>See A. W. Mayo Robson, in Lancet, April 12, 1902.

## DISEASES AND INJURIES OF THE PANCREAS.

Wounds and Injuries.—The pancreas is very rarely ruptured all although this sometimes occurs as the result of blows or crushes. In majority of cases in which the pancreas is damaged other organs are volved; for instance, the stomach, the spleen, and the liver. A gunsh wound of the pancreas is almost certain to injure the left kidney, the stomach or the vertebral column. It will be remembered that in the case of Preside McKinley the bullet passed through the stomach, damaged the left kidne and injured the pancreas. Garré ("Beitrage zür Klinische Chirurgie," xloo. 1) collected 30 cases of subcutaneous rupture of the pancreas and in on 8 of these cases was the pancreas alone damaged.

Symptoms.—When the pancreas is injured alone, hemorrhage is no usually severe; but if adjacent organs are also damaged, it is sure to be profuse. Hence when adjacent organs are damaged there are apt to be immediate symptoms of severe intra-abdominal hemorrhage; but profound colapse is not often present when the pancreas alone is injured. In fact, sympanic toms may not arise for a considerable length of time after injury of the parcreas. A diagnosis at this stage is impossible without exploratory operation Severe injury of the pancreas is usually, but not invariably, fatal. After slight damage of the gland the patient may completely recover; but, as a rule he partly recovers, and, after a number of weeks, a smooth tumor, palpable in the epigastric region, is formed. When operation is performed, this tumor is found to be back of the stomach. It contains a quantity of blood clot, and pancreatic fluid. Such a fluid collection is in the lesser peritonea cavity and is called a cyst, though it is not a true cyst of the pancreas. Rolling son and Moynihan, in their valuable treatise on "Diseases of the Pancreas, explain the formation of this collection of fluid as follows:

The injury lacerates the posterior layer of the lesser sac of the peritoneul and the pancreas, to which it is adherent. Blood and pancreatic fluid enter the lesser peritoneal sac. Peritonitis follows. The foramen of Winslow blocked by adhesions; and the lesser peritoneal cavity, being now a clossac, is distended with a serous exudate mixed with blood and pancrea fluid. Collections of this character form very rapidly, and several pints may gather in a few days. Other results of injury to the pancreas are absorpancreatitis, and true cyst formation. A fistula may follow operation rupture of the pancreas. Such a fistula is very troublesome, often relicobstinately to heal, and the pancreatic fluid macerates the skin severely. Usual treatment has been to keep the fluid drained off. A treatment suggesty Wohlgemuth has proved successful in 5 cases ("Berliner Klin. Woodschrift," 1908, No. 8). The fistulæ heal in from three days to six weeks. The streatment consists of strict antidiabetic diet and large doses of bicarbona sodium before and after meals.

By cutting out carbohydrates a powerful stimulus to the flow of pancrejuice is removed. The bicarbonate of sodium lessens the activity of the stach contents before they enter the intestine and it is known that hydrochlacid strongly stimulates the flow of pancreatic juice.

Treatment.-Operation is imperatively demanded, although the p

ects are bad. Garré collected 8 cases, 3 were operated upon, and all died bid.). Garré reported a successful case of his own (Ibid.). The pancreas as torn in two and the pieces were separated. The splenic vessels were ninjured. The two portions of gland were sutured together. This stopped e bleeding. Gauze-packing was introduced. In a gunshot-wound of the odomen, when exploration leads the surgeon to surmise that the pancreas has en injured, this organ should be approached by dividing either the gastrocolic nentum or the transverse mesocolon. The pancreas may also be exposed by viding the gastrohepatic omentum. Accessory injuries must be carefully ted, and if a bullet has penetrated the posterior wall of the stomach, the ncreas is almost certain to be damaged. One should remember that, as rk says, even after opening the abdomen it is difficult to explore the pancreas, pecially in a stout person. If there is no evidence of posterior perforation of stomach by a foreign body, one may assume that the pancreas has escaped. hen the pancreas is exposed, if it is found to be bleeding, the bleeding vessels ould be ligated and the tear in the gland should be sutured, care being taken t to puncture the main duct of the gland. If this duct has been cut, it must carefully sutured. In some cases of gunshot-wound it is necessary to resect ortion of the gland. At the termination of an operation upon the pancreas sterior drainage at the costovertebral angle should always be obtained. It necessary to carefully drain away all escaping pancreatic fluid, as it tends cause necrosis of tissue with which it comes in contact.

In cases of crush with pancreatic injury the associated injury to other ructures usually proves rapidly fatal, but in a less severe case the abdomen by be opened for exploration, and if this is done, the surgeon should proted as previously directed.

The question of excising a lacerated portion of the pancreas is one of great terest. It is known that dogs have lived for some time after complete exsion of the pancreas. Four-fifths of the pancreas can be removed from a without producing permanent glycosuria, but if more than this is removed dog develops saccharine diabetes and eventually dies of it. In man, quite ge-sized pieces of the gland have been removed and recovery has followed. In the initial position of the pancreas is bury to the splenic artery.

Movable Pancreas.—In cases of splanchnoptosis the pancreas may come considerably displaced, though this condition cannot be recognized thout opening the abdomen. So far, I know of no case in which fixation been attempted, though, of course, theoretically it could be done.

Pancreatitis.—Pancreatitis often leads to the production of jaundice; ways to very rapid loss of weight; occasionally to the presence of fat and gar in the urine; sometimes to the presence of fat in the stools; and freently to the condition known as fat-necrosis. Robson and Moynihan point that when there is no diarrhea and the stools contain undigested muscleer, one may assume that there is a deficiency in pancreatic juice. When he is a blockage to the secretion from the pancreas, if salol is given by buth, salicyluric acid does not appear in the urine. The test is made by thing gr. xv of salol into gelatin capsules hardened with formalin (Sahli) diving them with a roll and a cup of water. If pancreatic ferment is in

the intestine, salicyluric acid appears in the urine in one hour or one hour a half; if the ferment is absent from the intestine, salicyluric acid is not forin the urine because the salol is not split up and absorbed. The for the acid is ferric chlorid, which, in the presence of the acid, tum the urine violet. The general cause of pancreatitis is infection. Of obstruction of the common bile-duct is followed by infection and su puration of the pancreatic ducts and pancreatitis. Besides the genes cause, which is infection, various exciting causes may be named, amowhich are gall-stones in the common duct and calculi in the pancrea ducts, traumatism, cancer of the stomach or duodenum, catarrh of the stom ach or duodenum, and many infectious diseases. It thus becomes evidence that the infection may be by way of the blood; but, undoubtedly, in the va majority of cases, the infection comes by way of the duct. One manner which the disease may be produced was suggested by Halsted and Opie, Baltimore: A stone becomes impacted in the outlet of the common due the pancreatic duct, where it emerges above the common duct, not being blocked. The bile and pancreatic juice are thus prevented from entering to duodenum, and the bile flows back into the pancreatic ducts.

ct:

That strange condition known as fat-necrosis is often present in pa creatitis. In fat-necrosis the fat is decomposed into fatty acids and glyceri The glycerin is absorbed, but the fatty acids unite with calcium salts are remain in the tissues, forming patches of yellowish-white color and varying size. These patches are found in the fat beneath the peritoneum, in the omentum, and in the mesentery, and even in distant parts (for instance the pericardium).\* It is an undoubted fact that fat-necrosis is not uncome monly found after diseases and injuries of the pancreas; and many assumthat it is produced by the entering of the ferment of the pancreas into the fatty tissue. How the ferment gets there is a matter of some doubt. I the case of a wound of the pancreas one can understand the flow of the secretion and its imbibition by adjacent parts; but in other cases one mus assume that it has been absorbed by the lymphatics and distributed to more distant parts. When one reflects that in some conditions of the pancreas there is no fat-necrosis, while in others this condition arises, it is presumable that the pancreatic conditions associated with it are such as to permit the fat-splitting ferment to diffuse into neighboring tissues.

In pancreatic disease hemorrhage into that organ is common. The hemorrhage is not, of necessity, fatal, but frequently is so. Occasionally death takes place as the result of sudden pancreatic hemorrhage in a person apparently in excellent health. It is thought by Robson and Moynihan that during the existence of cancer of the pancreas there is a strong tendency to excessive hemorrhage after operation. In one case of my own the patient bled to death after the performance of cholecystostomy for obstructive jaundice. The oozing of blood in this case was from the margins of the gall-bladder and the adjacent peritoneal surfaces. We therefore conclude that in certain conditions of the pancreas there is a tendency to local hemorrhage in that organ; and that there may also be a tendency to the development of a general hemorrhagic diathesis, the general hemorrhagic tendency being much increased if jaundice exists. During acute inflammation of the pancreas

<sup>\*</sup>Robson and Moynihan, on "Diseases of the Pancreas."

Demorrhage is almost certain to occur into that gland; in other varieties of inflammation hemorrhage may occur or may be absent. In degenerative lesions of the pancreas a material like unfermented pentose is frequently present in the urine. When the reaction for this material is obtained we speak of it as the Cammidge reaction, after its discoverer. (For Cammidge's improved method, see "Brit. Med. Jour.," May 19, 1906).

Forms of Pancreatitis.—This disease is divided by Robson and Moynian into the acute, the subacute, and the chronic form; and they say that ecorded cases demonstrate the fact that three distinct classes of inflammation ay arise: (1) Cases that die within forty-eight hours of the beginning of the trouble. In this group hemorrhage is usually found; and if fat-necrosis present, it is limited in area. (2) Those that live for some weeks after beginning of the trouble. In these cases the pancreas may become ecrotic or suppuration may occur. Fat-necrosis is usually wide-spread. (3) the third class of cases long-continued inflammation or repeated attacks roduce sclerosis of the pancreas.

Acute Pancreatitis.—The symptoms of this condition come on suddenly and consist of violent pain in the epigastric region, vomiting, constipation, pidity and weakness of the circulation, cold extremities, and collapse, with great fall in blood-pressure. Some maintain that collapse is due to trypsin, hers that it results from the absorption of toxic products from the gland. The in is extremely violent and is intensified in paroxysms, and there are distinct derness and rigidity of the epigastrium. The patient vomits the contents the stomach and then bilious matter. Distention soon becomes distinct the upper portion of the abdomen. The patient presents the appearance one suffering from peritonitis. This condition is not unusually mistaken for estinal obstruction, but in acute pancreatitis the constipation is not absorbe; the patient passes gas, and may even have a bowel movement as the ult of the administration of an enema. The condition is usually fatal thin a few days, but in very rare instances recovery takes place. In acute accreatitis from stone in the common duct there is no leukocytosis (Murphy).

The diagnosis cannot be made with certainty and is merely an inference. ginald Fitz tells us that the existence of this disease should be suspected en a person previously in good health, or who has complained only of asional attacks of digestive disorder, is suddenly seized with severe pain the epigastric region, followed by vomiting and collapse; and when, within anty-four hours or more, there appears a circumscribed swelling in the astrium which is resistant or tympanitic. When an exploratory incision made in the abdomen, if fat necrosis is detected, the diagnosis becomes

In acute pancreatitis the pancreas undergoes rapid necrosis, due, according ome experimenters, to the entrance into the pancreatic duct of bacteria from intestine, and according to others to digestion of the pancreas by its own ds. The fluids when normal certainly will not digest the pancreas. It seems bable that trypsin is "activated" by the entrance into the duct of material the duodenum and bacteria may be responsible for activating trypsin lya, in "Pflüger's Archiv.," cxxi, Heft 9 and 10).

Treatment.—Operation was suggested by Nahn, in 1903. The exploratory operation is carried out in front, and the earlier it is made the better. Robson

operates at once, even in shock. It is quite true that the patient might, if let alone, pass through the acute stage, and that a local abscess might then form, the treatment of which would be obvious. But the danger of waiting is too great to justify delay, and if suppuration should occur it might not remain local, but might spread widely in the retroperitoneal tissues. When observation after exploratory incision into the greater cavity of the peritoneum suggests the existence of acute pancreatis, the infected area should be exposed either above the stomach through the gastrocolic omentum. The pancreas should be incised, hemorrhage should be arrested by ligation or packing, an incision should be made at the costovertebral angle, and posterior drainage should be made from the lesser peritoneal cavity. One should follow the rule laid down by Rosswell Park, and explore in every case in which the disease is suspected to exist.

Subacute Pancreatitis.—Subacute pancreatitis comes on suddenly, with violent pain, vomiting, and constipation, but there is far less exhaustion and weakness than in the acute form. The vomiting is less marked and the swelling in the epigastric region is not so rapid. The symptoms are similar to those of the acute form, but not so violent nor so rapidly progressive. The temperature frequently rises higher than in the acute form, and it may become irregular or chills may occur. In many cases the patient seems to grow better after a time, the violent pain abating, though some pain and tenderness remain; but he does not gather strength and continues to lose flesh, and there is usually albumin and there may be sugar in the urine. In rare instances fat is found in the urine. In subacute pancreatitis abscess is prone to form. This abscess may make a distinct swelling in front, and may lead to the development of a subphrenic or of a perirenal abscess. In rare cases an abscess of the pancreas tracks its way for a long distance in the subperitoneal tissue, occasionally it opens into the stomach or bowel Cases of subacute pancreatitis occasionally recover after a long illness, but usually they die.

Treatment.—Exploratory incision. Expose the pancreas, either above obelow the stomach; determine the condition; remove purulent matter an ecrotic areas; arrest hemorrhage with packing; and insert posterior drainag at the costovertebral angle. In some cases close the anterior wound, an in others leave it open.\*

Wm. J. Mayo† reports a successful operation for subacute pancreatitie. The patient was a man of fifty-two years, who, seven days before Mayo sawhim, had developed violent pain in the epigastrium, collapse, distention, an other signs of intestinal obstruction; but some slight movements had take place from the bowels, as the result of medication. On admission, the abdomen was tympanitic. An ill-defined mass the size of a fist could be palpated to the right of and above the umbilicus. The pulse was 120 and very weak the temperature, between 101° and 102°; and there were slight jaundice, restlessness, and hiccough. A diagnosis of gangrenous cholecystitis was made. The abdomen was opened, and the omentum was found to be studded with thick, adherent, infiltrated round spots, the size of a pea or larger. There were some similar spots in the mesentery, and the peritoneal cavity con-

<sup>\*</sup> Roswell Park, Annals of Surgery, December 15, 1901. † Jour. Am. Med. Assoc., Jan. 11, 1902.

tained bloody fluid. On palpation, the pancreas felt like a pudding in a tight sac; and on aspiration a little blood was obtained. The gall-bladder was opened, a stone was removed, and some pus was evacuated. Drainage was inserted into the gall-bladder, and eighteen days later there was an enormous flow of bloody fluid, containing bile and pancreatic juice, from the drainage-tube. The patient recovered. This plan of treatment—free drainage of the pancreas by the performing of cholecystostomy—is to be taken into consideration.

Chronic Pancreatitis.—There are many causes of chronic pancreatitis, viz., syphilis, alcohol, bacteremia, block of the common duct (stenosis, stone, etc.), extension of inflammation from the bile-ducts, and ascending infection from the duodenum. It usually results from disease of the bile-passages and is often associated with gall-stones. In 2200 operations performed by the Mayo brothers on the gall-bladder and bile-ducts, the pancreas was found diseased 141 times (6.4 per cent.).

In 168 cases of pancreatic disease on which they operated, 81 per cent, were caused by or, at least, associated with gall-stones. In operations upon the common or hepatic ducts the pancreas was diseased in 18.6 per cent, of cases. It was diseased in 4.45 per cent. of cases of operation upon the gall-bladder. Chronic pancreatitis produces enlargement of the organ, and the enlarged area is hard and feels like a malignant growth. This condition is more common than is the acute or subacute form. Robson and Moynihan have operated upon 30 cases. The disease is frequently associated with gall-stones or with stones in the pancreatic duct, and occasionally with ulcer of the stomach or of the duodenum. In some cases symptoms of the condition come on acutely. Pain, mausea, and vomiting occur, and jaundice develops rapidly, as it does after the passage of a gall-stone. It is noted, however, that the pain is not in the region of the gall-bladder, but is in the middle of the epigastrium, and it passes to The left rather than to the right. The tenderness, too, is in the middle of the epigastrium and not in the gall-bladder region. There is either constipation or diarrhea. A series of these attacks may occur, the jaundice growing worse after each attack. In some cases, however, the condition comes on gradually and insidiously, the pain slowly developing, but no violent seizures taking place. There are rigidity of the rectus muscles, rapid loss of flesh, anemia, sometimes bronzed skin, usually vomiting, and considerable flatulence. The gall-bladder is enlarged and commonly palpable.

In some cases it is possible to palpate the inflammatory mass. There may be irregular fever and chills with episodes of subnormal temperature. None of the above indications are conclusive signs of disturbed pancreatic function. Signs of disturbed function of the gland are of great importance in making the diagnosis, and these signs are glycosuria and impaired power of digesting fats and proteids (Walko, in "Arch. f. Verdanungskrankheiten," 1907, xiii). Fatty stools containing bile and unsaponified neutral fat are very significant.

The jaundice in chronic pancreatitis results from compression of the duct by hyperplastic mass, or blocking of the duct by a stone. Stenosis of the denum may occur. In jaundice from chronic pancreatitis capillary hembage is particularly common (Robson). Mayo Robson attaches much importance to the Cammidge reaction. In the Jefferson hospital we regard it as of decided use, but we do not as yet attach as much importance to it as

pated; but sometimes diarrhea occurs, and the movements may even contain blood. If the tumor presses upon the common bile-duct, jaundice will develop. The patient loses flesh markedly and with considerable rapidity, and he becomes very weak. In rare instances fat is present in the stools, and in other unusual cases sugar is found in the urine. A test should always made with salol, to see whether pancreatic ferment is present in the intesre (page 1039). In the beginning the pancreatic cyst is behind the stomach; t it enlarges and, as a rule, pushes the stomach upward and to the right e, and the transverse colon downward. The cyst approaches the surface the abdomen below the greater curvature of the stomach (Robson and oynihan). The same authors tell us that in rare cases the cyst appears the upper border of the stomach, and that in others it inserts itself between layers of the transverse mesocolon. In the case upon which I operated had worked its way through the subperitoneal tissue into the right loin, had been looked upon by Professor Montgomery and myself as a hydrohrosis. As a rule, the pancreatic cyst is immovable; but in rare instances movable. When a hand is placed in the loin and another on the abdon, ballottement may be appreciated. If the distended stomach or colon rlies the tumor, there will be a tympanitic percussion-note; but when tumor reaches the abdominal wall, there will be a dull percussion-note. inquiring into the history of these cases, it will frequently be found that the has been a severe injury to the upper abdomen.

Treatment.—Exploratory incision makes the condition clear. In the ority of cases the cyst is incised, emptied, and stitched to the wall of abdomen. This operation may be done in two stages—first, exposing cyst and fixing it to the abdominal wall; and, second, when adhesions have ned, opening it. As a rule, however, it is performed in one stage, the ominal cavity being carefully protected with gauze. Some authors advoexposing the cyst, opening and evacuating it through the abdominal and, and draining through the loin. Complete extirpation is usually implied because of the adherence of the cyst. If the cyst is movable, extirpation be carried out; but the safest operation consists of incision and drainage.

Tumors and Other Growths of the Pancreas.—The pancreas may be affected with sarcoma, carcinoma, adenoma, tuberculous disease, or syphilis.

Treatment.—Attempts have been made to remove tumors of the pancreas. After an exploratory incision has determined the condition, the pancreas is exposed at the point at which the tumor projects. This is usually by an opening in the gastrocolic omentum. If the tumor is in the tail the pancreas, however, the exposure may be effected in the flank. When tumor has been exposed, an attempt may be made to enucleate it. Tumors the splenic portion of the pancreas have been removed. Total pancreatectory or complete resection of the head of the gland should not be attempted.

In a large tumor of the head of the pancreas palliate the condition by lecystenterostomy. Villar reports 13 cases of partial resection of the pancreas for tumors with 5 recoveries from operation ("French Surgical Congress 1905").

## INJURIES AND DISEASES OF THE SPLEEN.

Wounds of the Spleen.—A wound of the spleen causes great hemrhage, and if surgical aid is not soon at hand, will inevitably produdeath. It is caused by a bullet or a stab and, as a rule, other viscera are all
damaged. Immediate operation is indicated.

Rupture of the spleen is unusual if the organ be healthy, but does occ sionally occur from crushes. It is rarely found unassociated with other injurious The spleen may be dislocated as well as ruptured. An enlarged spleen is pass ticularly liable to rupture not only from a crush, but from a kick, a blow, or fall. Rupture of the spleen produces pain and rigidity in the left hypocho driac region and the signs and symptoms of intra-abdominal hemorrhage There is tenderness over the spleen, pain over the heart, and great shortneof breath. The bleeding is profuse, but sometimes slow. The splenic blood comtains numerous leukocytes and clots rapidly, hence the bleeding may be arrested for a time, and if it should be the patient will not bleed to death rapidly and reaction will generally occur (Ballance). The blood in some cases clots so rapid that it gathers in the left loin, and is not commonly diffused throughout the abdomen. It gives rise to an increasing area of dulness on percussion in the left flank, which, Ballance points out, does not shift when the position of the patient is shifted, as it does in bleeding from other intra-abdominal structure In some cases, however, the blood remains fluid and spreads throughout the belly, and then there is rising dulness in each flank. The case reporteby Le Dentu and Mouchet shows that the blood may remain fluid ("Bul de l'Academie de Med.," June 16, 1903). In some cases the signs of heme orrhage are late and they may even be deferred until the fourth day (Eisen drath, "Annals of Surgery," Dec., 1902). Exploratory incision will be required to certainly recognize the condition. In Elder's table there are uncomplicated cases, not a case was operated upon (operation was nothe rule until 1890), and 84.6 per cent. died. Eisendrath has collected 50 cases operated upon: 56 per cent. recovered and 44 per cent. died.\* Février has collected 56 ruptures of the spleen. In 46 cases operation was performed and the mortality was 50 per cent. E. Berger ("Archiv. für klinische Chirurgie," Bd. 28, Heft 3) collected 168 fatal cases of rupture of the spleen: 145 died during the first day and every one died from hemorrhage. After the first day 23 died. In 90 per cent. of the entire series hemorrhage caused death; in 10 per cent. infection was responsible for death. The same author collected 67 cases treated by splenectomy and 38 of them recovered. Hemorrhage is the great danger in ruptured spleen-hemorrhage of the parenchyma rather than from the great vessels. The parenchyma is friable and contains multitudes of capillaries and veins, there is no muscular tissue, divided vessels do not tend to contract, and the capsule is thin. (The elder Senn, in "Jour. Am. Med. Assoc.," Nov. 21, 1903.)

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Treatment of Wounds and Rupture.—The treatment is evident from the previous remarks. It is as follows: Open the abdomen immediately, the patient being surrounded with hot bottles and hot salt solution flowing

<sup>\*</sup>Daniel N. Eisendrath, Jour. Am. Med. Assoc., Oct. 25, 1902. †Rev. de Chir., Nov., 1901.

we may do splenectomy (total or partial), may use the suture, the cautery, or the tampon, and any other visceral injuries are, of course, attended to.

The usual operation has been total splenectomy. In partial splenectomy

The arrest of hemorrhage by suture is known as splenorrhaphy. Lamarchia, in 1896, was the first to perform this operation. The tear or wound is sutured with catgut and the suture line is covered with omentum. Berger collected 14 cases of suturing with 2 deaths, but these were injuries of less severity than those requiring splenectomy. In some cases the tampon can be used. Berger collected 10 cases with 1 death. Another method is to rush the splenic structure slowly with broad forcipressure forceps and suture the crushed margins with catgut. Senn followed this plan. George Ben Johnston (paper read before "Johns Hopkins Med. Soc.," March 2, 1908) has collected 150 cases of splenectomy for wounds or ruptures, with 99 recoveries and 51 deaths, a mortality of 34 per cent.

Abscess of the spleen is a rare condition which is usually metastatic in origin. It may follow typhoid, may develop during pyemia, or may result from injury. Chronic suppuration may be due to tuberculosis or actinomycosis. Pain is felt, and enlargement is noted in the splenic region, and the symptoms of pyemia exist. The abscess may become adherent to the belly-wall, may become encapsuled, or may rupture into a viscus or the peritoneal cavity. Fluctuation can seldom be obtained. What is known as a tropical abscess (Fontoynant and Jourdrau, in "Archiv. Prov. de Chir.," No. 11, 1902) may develop during a malarial attack as a result of severe exertion. There are severe pain in the left hypochondrium, dyspnea, and dry tongue. There may or may not be fever. The pus may be sterile.

The treatment of abscess of the spleen consists in incising the abdomen at the outer edge of the left rectus muscle, suturing the spleen to the abdominal wall, opening the abscess, and providing for drainage (Tédenat\*). If the abscess is adherent to the abdominal wall, incise it directly. There are 9 recorded cases of splenectomy with 1 death (George Ben Johnston, Ibid.).

Enlargement and Tumors of the Spleen.—The spleen undergoes by pertrophy in the course of infectious disease, from amyloid disease, from alaria, from splenic anemia, from tuberculosis, from leukemia, and from tuberculosis, and sarcoma occasionally develop. Jepson and Albert reported a case of primary sarcoma of the spleen and collected 31 others from leukemia, and is sometimes melanotic. Secondary carcinoma is usually medullary and is sometimes melanotic. Secondary carcinoma and secondary cancer, as stated above, is seen after cancer of the stomach. Hydatid cysts, dermoid cysts, lymph cysts, serous cysts, and blood cysts occasionally develop. There are on record 12 cases splenectomy for sarcoma: 9 recovered and 3 died (George Ben Johnston, lbid.).

Treatment.—The condition may become clear only after exploratory la parotomy. For some tumors splenectomy is indicated. A hydatid cyst is \*Rev. de Gynéc. et de Chir. Abd., July, August, 1901.

treated as is a cyst of the liver (page 1016). A blood cyst is sutured to the incision in the abdomen and is drained.

Splenoptosis, or Wandering Spleen.—The spleen may wander intoany part of the general peritoneal cavity. This condition is seldom met with the except in women. It is most common in women who have borne children and A wandering spleen may undergo atrophy, engorgement, or axial tation (J. Bland Sutton). The spleen may be healthy or enlarge from malaria or leukemia. As a matter of fact, it is usually diseased. T organ when displaced drags upon the stomach, producing dilated stomac it may interfere with the bile-duct, causing jaundice; it may cause intestimate obstruction by forming adhesions, or may cause uterine retroflexion or p lapse by passing into the pelvis.

J. Bland Sutton says this condition may endanger life, as it may le to rupture of the stomach, intestinal obstruction, splenic abscess, or sple rupture.\* A wandering spleen can be identified by the fact that it has notch upon its edge, and can be pushed about the abdomen. When t condition exists, the spleen may be missed from its normal situation. Alw examine the blood in order to determine if leukemia or malaria exists.

Treatment.—Greiffenhagen advocates suturing the organ in place (sple= pexy). Most surgeons prefer to perform splenectomy. In a case with leukemia the operation is very successful. Splenectomy for wandering sple is rarely followed by serious blood-changes or other trouble. The reas is that a wandering spleen is usually a diseased organ, having undergo -pic hypertrophy or fibroid change, and other structures have taken on splen function. Splenectomy should not be undertaken if leukemia exists. ent such a case surgeons usually apply a support and employ medical treatme for the existing disease or endeavor to suture the organ in place. If spleen were enlarged by malaria, I would perform splenectomy (as I in one case). If the spleen were healthy, I would surround it with gaussian exactly as is done with the kidney in a case of movable kidney. If the sple were enlarged by leukemia, I would not operate.

In

## OPERATIONS UPON THE ABDOMEN.

Abdominal Section (Celiotomy; Laparotomy).—There are many different methods of opening the abdomen. The plan selected depends up the nature and the situation of the disease, and upon the inclinations at an and the custom of the operator. The abdomen may be opened to attack a recognized seat of disease or to determine what the disease is and where it is situated Abdominal section performed for the latter purpose is spoken of as explorate any section or exploratory incision.

Of recent years, exploratory operations have become extremely commented and many abdominal conditions would be unrecognized without such explanations tion, or would be recognized at so late a period as to be beyond the reof surgery by the time the diagnosis had been made. This is notably of the surgical diseases of the stomach. The surgeon should, however, be too radical in employing exploratory operations. The fact that he

plore with such comparative impunity does not release him from the oblition to endeavor by every proper method to make a diagnosis before reting to operation. I fancy that of recent years the belief that it is almost ste of time to make prolonged efforts to diagnosticate many intra-abdomd troubles because the solution is so much easier by section, has become common as to have led young and unskilled operators to perform secn in cases in which the diagnosis might have been made without this occdure.

Before opening the abdominal cavity for exploratory purposes or to gain cess to some area of abdominal or pelvic disease the patient is carefully epared as for any other operation. In an appendicitis case the patient moved with the utmost care and is prepared for operation most gently, cause of the possible danger of rupturing an abscess. In an emergency se no prolonged or complicated method of cleansing can be employed. ne abdomen and loins are scrubbed carefully with soap and water, special ention being given to the umbilicus; the pubic region is shaved, the soapis are washed away with sterile water, the surface is gently scrubbed with ohol and then with a hot solution of corrosive sublimate (1:1000), and covered with gauze wet with the sublimate solution. As previously stated ge 50) we no longer regard it as necessary to "prepare" the abdomen the before. The patient can be prepared antiseptically the morning of operation, or can be shaved just before etherization, and be cleaned n under ether. The instruments required depend upon the nature the case. As a rule, there are required scalpels, scissors, a dry dissector, pairs of dissecting forceps, hemostatic forceps, pedicle forceps, Hagedorn dles, calyx-eyed intestinal needles, a needle-holder, drainage-tubes, gauze s, gauze for sponging, silk, catgut, silkworm-gut, the Paquelin cautery, electric light, also an instrument and a saline solution for hypodermoclysis ntravenous infusion. Always count the instruments, sponges, and pads, write down the number, and count them again after operation. This rule dopted so that no instrument, sponge, or pad will be left in the abdomen. e abdominal pads and sponges are not used when dry. Dry sponges injure peritoneum and favor the subsequent development of adhesions (Sanger). e pads and sponges should be wrung out in hot normal salt solution before ng used.

Operation.—An anesthetic is given. In some cases the patient is placed umbent; in others, is put in the position of Trendelenburg (Fig. 529). In Trendelenburg position the pelvis is elevated, the intestines fall toward epigastrium, are removed from the necessity of being handled and from danger of being bruised, the pelvis is thoroughly exposed, and work comes easier and safer. This position should not be used if there myocardial disease, as the increased pressure in and flow of blood on the inferior cava may cause fatal acute dilatation of the heart raske, of Freiburg, in Proceed. of German Surg. Congress, 1903). The sition is of little use in very fat people (Trendelenburg), and in such subject may cause intestinal obstruction (Kraske). When this position employed, the table should be lowered as soon as possible, because stric hemorrhage may occur (von Eiselberg). The normal position

should not be suddenly assumed, as this may cause intestinal obstruthe omentum being mixed with coils of intestine, pulling the colon (Pasteau, in "Bulletins and Mém. de la Soc. Anat. de Paris," July, The position should not be used in a pelvic abscess (König), as it mate to a flow of pus from the pelvis into the far more dangerous regions a

Volvulus of the ileum and also volvulus of the large intestine have fol



Fig. 529.—The Trendelenburg position.

the use of the position. If the Tren burg position was employed, before closi belly return the omentum to its proper tion and spread it out (Lauenstein every abdominal operation the patient is carefully protected from cold, the extre and the chest are covered with blanket sterilized sheets are placed well aroun field of operation. The skin is sterilized immediately before operating. The st

steadies the skin of the belly with the fingers of his left hand, and, holdi knife free in the right hand, makes an incision. For purposes of explorati incision is made about two inches in length, and it is lengthened if it is necessary. The abdomen may be opened in the median line above or the umbilicus. This incision is advantageous for operations on the for general exploration, and for certain procedures upon the stomac intestines, and the left lobe of the liver. The closure of such an incision ever, lacks strength, as compared with the closure of an incision where muscles will overlie the scar through the peritoneum and the transv fascia. Incision through the semilunar line is practised by a number of ators. A favorite incision is through the rectus muscle. The fibers of muscle are separated, the structures beneath it are divided, and, after the pletion of the operation, the deeper structures are sutured and the parts separated muscle are allowed to fall together. The scar resulting from an incision is well supported and solid, hence the likelihood of hernia deing is diminished. A favorite method with some is to open the sheath rectus muscle, retract the entire muscle aside, incise the posterior pe of the sheath and the structures back of it, and, when the operation has completed, allow the entire muscle to come back into place, and thus s then the deep-seated scar. When the abdominal trouble is in a region admits of it, I almost invariably go through the rectus muscle or retraction entire muscle. Besides these methods, there are special incisions, su for particular cases: An incision along the costal margin, for reaching gall-bladder; an incision shaped like the italic letter "j," for the same pose; special incisions for certain operations upon the stomach, for about nal nephrectomy, etc. Some operators have even used a transverse inc in certain pelvic operations.

In an operation through the median line the first cut goes to the aprosis of the external oblique muscle. Clamp the vessels. Do not hus the linea alba below the umbilicus, but go right through or between recti muscles. Above the umbilicus the linea alba is very distinct an surgeon often cuts through it. Divide the transversalis fascia, beneath y

is a little fat, and expose the peritoneum. The latter structure is recognized by its glistening appearance, by the ease with which it can be pinched up between the finger and thumb, and by the readiness with which its opposed surfaces may be made to glide over each other. On identifying the peritoneum, catch it at each side of the incision with forceps, raise a fold, nick it with a knife, and open it with scissors to the length of the external wound, To prevent stripping of the peritoneum a good plan is to anchor it to the belly-wall with a stitch on each side of the incision. Through the wound thus made the abdomen and its contents are explored, the trouble located, and determination made as to whether or not further operation is advisable, and, if it is advisable, what form it shall take. It may be necessary to enlarge the wound. This is done by placing the index and middle fingers of the left hand in the belly, with their pulps against the peritoneum, in the line where the surgeon will cut, to serve as supports to the scissors and as guards intraperitoneal structures. The scissors are introduced and the wound is enlarged upward, around the umbilicus if necessary. As soon as the incision is complete it is a good plan to push a large pad into Douglas's pouch and leave it there until the operation is finished, when it must be removed. Slender adhesions are stripped off with the finger or are pushed off with gauze; firm adhesions are tied in two places and cut between the ligatures.

The toilet of the peritoneum is important after the operation is com-Pleted. Following a clean laparotomy, when but little blood has flowed into the cavity, flushing is not required; if much blood has flowed or if septic tter has passed into the peritoneal cavity, after removing the sponge from Douglas's pouch flush the belly thoroughly with hot normal salt solution, pty out most of the fluid, but let a pint or more remain in the abdomen. In shing the abdomen bear in mind Monks's observations as to the mesentery. is a sort of shelf. If we follow down the left side of it with the finger the ger must enter the left iliac fossa; if we follow down the right side of it finger must enter the right iliac fossa. Hence in order to flush the right ity carry the nozzle down the right side of the mesentery to its root, and order to flush the left fossa carry it down the left side of the mesentery to root (Monks, "Annals of Surgery," Oct., 1903). The retention of the In a fluid in the belly minimizes shock. It is absorbed with great rapidity er the operation if the patient is placed with his head lower than his feet, ause in this position the saline fluid gravitates to the diaphragmatic region, here absorption is very active; in fact, in one hour the peritoneal cavity absorb from 3 to 8 per cent. of the body weight. If there is wide-spread ection with stomach-contents or feces, eviscerate, wipe out the peritoneum pads soaked in hot normal salt solution, and wipe the intestines carey, slowly returning them as they are wiped. Extravasated septic matis apt to collect in the peritoneal fossæ and between the liver and dia-Phragm, and these regions must be carefully wiped or irrigated. In cases septic and purulent peritonitis flushing, evisceration, and wiping with Sauze are not advisable (page 1006). In some cases it is desirable to drain through a lumbar incision. Rutherford Morison has pointed out that a bar opening into the right kidney pouch will drain a fossa which holds

over a pint of fluid, and which, when the patient is recumbent, is the modependent portion of the peritoneal cavity. In some cases a drainage opening is made on each side of the belly or above the pubis or through the vagina. In septic cases it may be advisable to drain with several pictorio of iodoform gauze instead of inserting tubes. After most laparotomies drain is not needed, but it should be used when stomach-contents were extrasted, and it must be used if feces or urine were extravasated, in certain receptic cases, and when hemorrhage has been severe. We may drain be rubber tube, strands of gauze, or a glass tube. If a glass tube is used, introduced at a lower angle of the wound and reaches the bottom of pouch of Douglas. This tube is repeatedly emptied during the proof of the case by means of a syringe. Before closing the wound arrest loor or sponge has been left in the belly.

It is highly important that an abdominal incision shall be accurate closed, for any failure of neat approximation will, in all probability, in the formation of a hernia through the cicatrix. Various methods been employed. Probably the majority of operators use layer sugar sewing up the peritoneum with a continuous suture of catgut, and the neurotic layers with the same material or with chromicized catgut, and cl the skin with either interrupted sutures of silkworm-gut or a subcutic stitch of catgut, silkworm-gut, or silver wire. Other operators close peritoneum with a continuous suture of catgut, then pass silkworm sutures through all the other structures, leaving them for the time un put in layer sutures of catgut or of chromicized catgut, and then tie silkworm-gut sutures. A layer suture makes a beautifully neat approxition, and is frequently quite satisfactory; but I have become persuaded the dead space, so often left unobliterated when this method of sutur is employed,—a space in which blood and inflammatory exudate may gather is a danger to the future integrity of the wound. The combination o dead space with catgut, a material that is always somewhat uncertain, an unfortunate one from the surgical point of view. Recently I have turned to the use of the through-and-through suture in many cases, applied cording to the method of Dr. Joseph Price. This suture is inserted with straight needle, is composed of silk or of silkworm-gut, is put in close to the gin of the skin, gathers up a great deal more muscle than skin, and then p close to the margin of the cut peritoneum and transversalis fascia. these sutures are adjusted, the peritoneal edges are brought into accurafirm apposition, the peritoneal surface is overlaid with abundant musc skin edges are brought into neat approximation, and the formation of space is rendered impossible. When passing the sutures have a gau under the wound and be very careful not to include bowel or on It is necessary to tighten and tie most carefully to prevent omentury caught in the loop of the stitch. After closing a laparotomy wour with aseptic gauze and wood-wool and apply a flannel binder. infected cases the wound is often kept open.

If a two-inch incision has been closed without drainage and prim has taken place, the patient can usually get out of bed in seven or e A large incision offers greater danger of subsequent hernia, and the patient should be kept in bed for two or three weeks. If the wound has been kept open for drainage, a prolonged retention in bed may be necessary. I get patients up at an earlier period than used to be my custom, but I do not get them up as do Kümmell and others in from one to three days (see Kümmell, in "Zentralblatt f. Chirurgie," 1908). To get them up reasonably early lessens constipation, favors an early return of appetite and strength, and diminishes the risk of postoperative thrombosis and embolism and of bronchitis. We must bear in mind that if there is myocardial degeneration very early getting up may prove disastrous, or even fatal, and that in septic diseases there is often myocardial degeneration (see E. W. Foote, in "Progressive Medicine," June, 1909). In a case in which an incision of considerable length has been made, an abdominal support should be worn for a variable time. It limits the movements of cough, laughter, etc., and reminds the patient of the necessity of caution in lifting, hurrying, etc.

After-treatment.—The after-treatment depends somewhat on the case, but certain general rules can be laid down. The late J. Greig Smith said many wise things, and among them this: "A golden rule in the treatment of cases of celiotomy is to let the patient alone. Everything approaching to meddlesomeness is to be condemned. The patient must not be upset by fussy applications of tentative therapeutics; when an emergency arises, it is to be met, promptly and decisively, by a method which has been approved trustworthy" ("Abdominal Surgery"). In many cases, immediately after the operation the patient must be treated for shock by methods previously set forth. The treatment of vomiting resulting from the administration of an anesthetic is discussed on page 1197. If vomiting persists during the third or fourth day, it is probably due to the development of inflammation which has caused intestinal paresis; and if it is so produced, medicine is practically useless. In this condition there is usually marked tympanitic distention, and vomiting is, in a sense, a relief. Nothing should be Siven by the mouth, and the patient should be fed entirely by enemata. The insertion of a rectal tube and its retention for a considerable time may ford relief. Lying on the side is more comfortable than recumbency. ashing out the stomach from time to time gives great comfort and is often of real service.

In the average case of celiotomy, in which persistent vomiting does not ur, the question of feeding is of much importance. Usually, for the twelve or twenty-four hours, nothing is given by the mouth but small antities of hot water. The day after the operation, if everything is satistory, food is given to the patient. In many cases, however, food is not en by the stomach for forty-eight hours and the patient is fed by the recduring the wait. He should not be given milk, because it will not be ally digested, may lead to nausea, and causes flatulence. Peptonized if the patient will take it, does not possess these hurtful qualities. At albumin-water or liquid beef peptonoids should be given and later entine's meat-juice, beef-jelly, broth, etc. Food is given every third or the hour, and stimulants are administered if required. After the first enty-four or forty-eight hours considerable quantities of plain water or

Poland water should be taken, when possible, to favor elimination by the kidneys. Hot coffee is not only a stimulant, but is an excellent diuretical aic. The urine is always scanty after an abdominal operation, and a normal analysis analysis and a normal analysis daily amount is not voided for ten days or more. Solid food is not give for seven or eight days. The patient is apt to suffer greatly from thin set, in spite of the hot water given during the first twelve to twenty-four hou are It does not do to give any considerable amount of hot water, and cold waand ice are inadmissible and tend to induce nausea and vomiting. The can be much mitigated by enemata of water. J. Greig Smith recommenan enema composed of from 4 to 20 ounces of tepid water and some brandly. Usually, after the first twenty-four hours, a sufficient amount of liquid be given to keep the patient free from actual distress.

Tf The bladder must be watched to see that retention does not occur-M retention occurs, a clean catheter must be used at regular intervalstympanitic distention occurs after forty-eight hours, a saline purgative sh be given and it should be followed by an enema of turpentine (page 10 The rectal tube is frequently of signal service in such cases. If obstruc-

develops, it is treated as directed on page 976.

In any ordinary case after operation the bowels should be moved forty-eight hours as a prophylactic measure against distention, peritor tis, and obstruction. From four to eight one-dram doses of Epsom salts are gi in hot water, the solution having been filtered through gauze. The some is followed by the administration of an enema consisting of soap, water, half an ounce of castor-oil. Should opium be given? Never as a tine, and not to secure sleep; but if the patient is in pain which not harasses him but causes him to turn and shift in torturing restlessness, or possibly two hypodermatic injections each containing 1 gr. of morp can be given with confidence that the good will overbalance the harm.

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Operation for Appendicitis.-Before operating try to locate situation of the appendix, and the relation the area of infection bears the ascending colon. The incision should be over the seat of disease. the rare left-sided cases and in median cases the incision is median. In so cases where the appendix is posterior the cut may be in the loin. In case I opened a purulent collection through the rectum. In the vast major

of cases the incision is made in the right iliac region.

In acute appendicitis when there is not thought to be a distinct absorb the incision usually made is two inches internal to the anterior super iliac spine and perpendicular to a line drawn from the spine to the umbilic (Fig. 530). The skin incision is usually three inches in length, the upp third of the incision being above the omphalospinous line; the incision the peritoneum is about two inches in length, but if there are man adhesions, it may be necessary to make it much longer. The oblique incision may be carried out as advised by McBurney, the muscles being separated by blunt dissection. By this method very few nerve-fibers an divided, and hence the operation is not followed by marked muscula wasting, a condition which strongly predisposes to hernia. Further, Van Hook points out,\* the oblique incision enables the surgeon to reach

<sup>\*</sup> Jour. Amer. Med. Assoc., Feb. 20, 1897.

the ordinary areas of appendix trouble, the wound is par-

the lines of tracabdominal muscles not tend to gape n an acute case I oblique incision, but iscles. In an interseparate the muss. Battle's incision er edge of the rectus preferred by many The anterior layer us sheath is opened ally, the rectus is ward, and any exion of the posterior ath with the transscia and peritoneum

used Davis's transion (Figs. 531 and nany interval cases re satisfaction G. Davis, in "Anrgery," Jan., 1906). ion does not divide and it divides the cles in the direction erves, hence the not injured. The this incision is althe base of the ap-Davis describes his s follows ("Annals y," Jan., 1906):

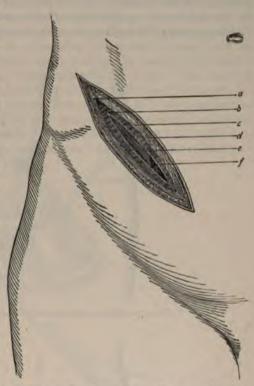


Fig. 530.—Resection of the vermiform appendix, incision through the abdominal wall: a, External oblique muscle; b, internal oblique muscle; c, aponeurosis of external oblique; d, aponeurosis of internal oblique; e, peritoneum; f, outer border of rectus abdominis muscle (under it the deep epigastric vessels) (Kocher).

asy cases the incision is made directly transverse, one and a half g. Its center is to be on the semilunar line on a level with the aperior spine. The aponeurosis of the external oblique is divided a of the skin incision, but obliquely to the direction of its fibers. of the internal oblique and transversalis muscles are parted—not be same line as the structures above. The peritoneum is then ad the incision carried inward, first through the anterior layer of the rectus. A blunt retractor three-quarters of an inch wide erted and the muscle drawn toward the median line. This exposes ersalis fascia and peritoneum posteriorly, which are then also divided. In the transport of an an amount of the structures of an an amount of the structures of an an amount of the cases.—If the case is a difficult one, the outer end of the inciplonged to the anterior spine or even above and inwardly through

the sheath of the rectus to within an inch of the median line. This give an opening four to five inches long according to the size of the pati sufficiently large to insert the hand if necessary and through which the applic can be extracted under almost all circumstances."

After opening the peritoneum examine very gently to detect the situa

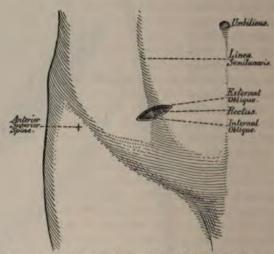


Fig. 531.-Davis's small transverse incision for simple cases.

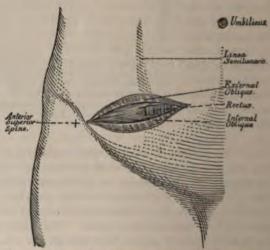


Fig. 532.—Davis's large transverse incision for difficult cases.

of the appendix, and if there are or are not adhesions. In a very recase and in a very acute case there will probably be no adhesions un there have been previous attacks. Surround the region of infection a strips of iodoform gauze, each strip being two and one-half inches wide teen inches long, and four layers in thickness. The edges of the wo

should be lifted up by retractors and the strips inserted around the cut, between the parietal peritoneum and intestines and to a distance of three inches from the wound. Strips of gauze are passed, when possible, below the appendix to prevent entrance of infected material into the pelvis, and a piece is pushed upward toward the liver (Van Hook). Over the iodoform gauze which it may be necessary to leave in place after the operation gauze pads are packed. The appendix is sought for by finding the colon. The colon is found by following the parietal peritoneum with the finger. The course of the finger is first outward, next backward, and finally inward; the first obstruction it encounters is the colon. The fact that it is the colon can be confirmed by finding the longitudinal bands. The anterior longitudinal band leads directly to the appendix. Pass the finger down to the head of the colon, find the appendix, usually posterior and internal, and lift it and the head



Fig. 533.-Radical operation for appendicitis (Kocher).

of the colon into the wound. In some cases it will be advisable to deliver the head of the colon from the belly (Fig. 533); in other cases this will not be necessary. The colon from the belly (Fig. 533); in other cases this will not be necessary. The colon from the belly (Fig. 533); in other cases this will not be necessary. The colon from the belly (Fig. 535) is a very satisfactory mode of removing the appendix. It is not as follows: Turn up a cuff of peritoneum, pull down the other coats, ligate the base, cut through the tube, let the musculomucous stump retract, and or suture the peritoneal cuff over the stump. Another method, which is the I usually employ, is as follows: Pass a ligature through the meso-appendix shown in Fig. 534, at A, tie the ligature, and cut off the meso-appendix below threads. Crush the stump of the appendix with strong straight hemostatic through. This divides the mucous membrane, submucous tissue, and muscular coat, and leaves the peritoneal coat undivided. Remove the forceps. Sur-

round the appendix with a catgut ligature and tie the ligature in the groove produced by the crushing. When the ligature is tied, peritoneum is brought against peritoneum (Fig. 534). Cut off the appendix between the ligature and a clamp with the cautery, a knife, or scissors. Disinfect the stump of appendix with pure carbolic acid. The stump beyond the ligature contains mucous membrane and muscle, which are lifted out with forceps and scissors. Suture the fringe of the meso-appendix and invert. Fig. 534 shows an older method still used by many. The meso-appendix is tied off by one ligature, the appendix is not crushed, but is tied off by another ligature, and both structures are cut off below their respective ligatures. The stump is disinfected with pure carbolic acid or the cautery, inverted, and the fringe of the meso-appendix is sutured. This method does not entirely remove the appendix, but inverts glandular tissue into the wall of the bowel. The stump may not be completely asepticized by the carbolic acid and hence may lead to postoperative abscess, dense adhesions, or fecal fistula, or the undestroyed lymphoid structure may cause future trouble, even persistent ill health (Joseph Price). Some remove

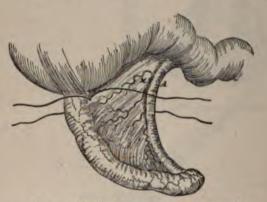


Fig. 534.-Ligation of appendix and meso-appendix.



Fig. 535.—Barker's technic operation for removal of the a pendix.

the appendix by an elliptical incision around its base, and close the collinoid wound by Lembert sutures. This method, of course, removes the appendix ompletely. Dawbarn surrounds the appendix with a continuous Lembertsering suture of silk. This is inserted in the superficial layers of eccum, half an inch from the appendix. The appendix is divided so as leave a stump never shorter than half an inch. The lumen of the stump gently stretched by inserting a pair of mouse-toothed forceps and opening blades. The stump is then invaginated into the cecum—that is, it is turn "outside in." The sutures are tightened, and while this is being done, mouse-tooth forceps used in effecting inversion are withdrawn. Finally, sutures are tied (Robt. H. M. Dawbarn, in "Internat. Jour. of Surg.," Mar 1895). In this method the stump is not ligated and hemorrhage is liable take place into the gut. Deaths from such hemorrhage are on record. Tretained bit of appendix drains into the colon. I believe it is a mistake trust to simple ligation and to fail to bury the stump left after appendectors.

If a surgeon follows this plan in any large number of cases, he will be apt now and then to have a case in which the ligature slips and feces pass into the perineal cavity, or cases of temporary fecal fistula, or cases of intestinal obstruction from adhesion of some portion of the bowel to the exposed stump (see Lurat Willis, in "Annals of Surgery," July, 1908). I do not believe that a pried stump increases postoperative pain.

If there is no pus or no extravasated feces, if the peritoneum is not seriously ected, if the appendix is not gangrenous or perforated, and if there is no pus thin the appendix, remove the pads, irrigate with hot salt solution, remove strips of gauze, and close the wound. If any of the above conditions were nd, remove the infected pads, but leave the iodoform strips in place to it infection and secure drainage. Pass sutures through the wound edges, some of the sutures and leave some untied until gauze is removed at a later iod (Van Hook).

If an operation is performed in a distinct interval, pus is absent and the seon can proceed without apprehension. If there is any question of the sence of pus, surround the region with gauze, as suggested above, before king down adhesions and liberating the appendix. An interval operashould not be performed until three weeks after an attack. In an interval McBurney proceeds as follows: He makes the skin incision in the director of the fibers of the external oblique muscle, separates the fibers of this le by blunt dissection, retracts them, separates the fibers of the internal que and the transversalis muscles in the same way and retracts them, and is the transversalis fascia and peritoneum. No muscle fibers are cut and he is not apt to follow. Such a wound is closed as follows: a continuous sut suture for the peritoneum, sutures of kangaroo-tendon for the transversalis fascia, the muscles are restored to place, the aponeurosis of the external oblique is sutured with kangaroo-tendon, and the skin is closed by a subcuticular stitch.

If an abscess is believed to exist, make an incision parallel with Poupart's ligament and over the area of dulness on percussion (Willard Parker's oblique incision). If the abscess is adherent to the anterior abdominal wall, such an incision will not enter the free peritoneal cavity. If, after opening the abdomen, an abscess is thought to exist, although it is not adherent to the anterior abdominal wall, surround the abscess with gauze before opening it, as directed under acute appendicitis. The gauze is placed under the margins of the incision in the peritoneum all around the appendix area; a piece is carried toward the pelvis and another piece toward the liver. Overlay this gauze th gauze pads (Van Hook). Adhesions are broken through with the finger, and when pus appears, it is at once wiped away. Remove the appendix in ost cases, but not in all. If the appendix lies loose in the abscess-cavity, it is sloughed off or but loosely attached to the abscess-wall, remove it. If appendix is firmly fixed in the abscess-wall and must be dug out of a mass inflammatory material, do not remove it. To remove it under these cirstances may rupture the wall and disseminate the pus into regions not Protected by pads and gauze. Deaver and others tell us always to remove appendix. I do not believe this to be a safe rule to follow. To insist removing the appendix may cause death. When the appendix is left, it

phlebitis, hepatic suppuration, metastatic abscesses, endocarditis, and ganrene of the bowel. In a further report from September 1, 1902, to September 1, 1903, Deaver reports 566 cases in the German Hospital, with an aggregate portality of 5 per cent. In cases with diffuse peritonitis the mortality was per cent. In abscess about a necrotic and perforated appendix it was per cent. In early appendicitis or when disease was confined to the appenix it was 0.8 per cent.

Appendicostomy (Weir's Operation).—This operation was devised Weir, of New York, in 1902. It consists in opening the abdomen, finding e appendix, fastening this structure to the skin, closing the rest of the wound, ening the appendix to see that it is patent, and applying a temporary ligature prevent leaking. The temporary ligature is removed in a day or two, a few days later the adherent and open appendix is used as a route for introduction of irrigating fluids. The operation is of the greatest value chronic ulcerative colitis, as it enables us thoroughly to irrigate the large wel. Daily a large tube is passed into the rectum and a small tube into appendix. The fecal matter is washed out of the bowel with salt solut and then a 1: 5000 solution of silver nitrate or bismuth and starch water ito the 3) is used to irrigate. It is used for the same purpose in some sof tuberculous rectal or anal fistulæ. A most extraordinary suggesis that appendicostomy be performed in epileptics, so that the opening be used to flush the bowel, a suggestion which I will not act upon. en the fistula exists, it does not leak to any appreciable degree. en we wish to close it, we insert within the lumen of the tube the Paquelin tery at a red heat. This destroys the mucous membrane and the fistula (Robt. Weir in "Med. Record," August 9, 1902).

Enterorrhaphy, or Suture of the Intestine.—Surgical opinion has
tly altered in regard to this operation since the day when John Bell wrote
amous attack on Benjamin Bell. John Bell said: "If in all surgery there
work of supererogation, it is this operation of sewing up a wounded gut."
lay we know that if in all surgery there is a proceeding of imperative
ssity, it is the sewing up of a wound in the intestine. To perform this
ation take fine sterile silk and thread a thin, round, straight, calvx-eyed

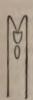


Fig. 536.-Eye of the calyx-eyed needle.



Fig. 537.—Enterorrhaphy:



A, Lembert's suture; B, Dupuytren's

rapidly by pushing the calyx eye down upon the silk thread while the latter is kept taut. Lembert's sulure (Figs. 537, A, 543, and 544) was devised in 1823. Lembert used it on animals, but never on man. It is inserted at right

serous membrane. A Lembert suture is added (Fig. 541). As at present used, the Czerny suture is carried to, but not through, the mucous membrane. Gussenbauer's suture is similar to the Czerny-Lembert suture, except that it applies the Czerny and the Lembert with one suture, and this suture does not pass through the mucous membrane (Fig. 546). In Connell's suture

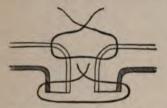


Fig. 541.-Czerny-Lembert suture.

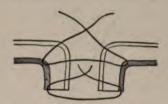


Fig. 542.—Czerny-Lembert suture as at present used.

Gregory Connell, in "Phil. Med. Jour.," Jan., 1899) the knots are placed in the lumen of the bowel (Plate 10). Connell's very useful and ingenious h seems to be a modification of a stitch described by Frederick Holme gin ("Med. Record," Nov. 19, 1898). Wölfler's suture unites broad its of the serous coat, the knots being tied internally (Fig. 545). Senn that after suturing a large wound of the stomach or of the intestine a of omentum ought to be laid over the wound and fastened by catgut res (omental graft). These grafts adhere and are a safeguard against age. (For other methods of enterorrhaphy see Intestinal Resection and stomosis.)

Operations upon the Stomach.—A patient must be carefully preed for an operation upon the stomach. The Johns Hopkins method, ded on the researches of Harvey Cushing regarding sterilization of the standard, is to be used. During the two or three days immediately preceding operation clean the mouth and teeth several times during the day with a carbolic solution. Give only sterile water and sterile liquid food by the mouth, and for twelve hours before operation give no food whatever. During the or three days before operation wash the stomach with boiled water night and morning. I do not wash immediately before operation, as it sometimes leads to annoying vomiting and thus may interfere with anesthetization. After operation give no food whatever for thirty-six hours. Small quantities of hot water are allowed as soon as the patient recovers from ether. During the first twenty-four hours give an enema of hot salt solution and coffee every five hours and then alternate nutritive enemata with salt enemata. After thirty-six or forty-eight hours usually begin to give food-at first small doses of albumin-water, and, if this is tolerated, broth and milk. Solid food should not be given for two weeks.

If the patient is advanced in emaciation and much exhausted we should not wait for thirty-six hours to feed him, but should give milk and broth as soon as the patient recovers from ether. The bowels should be moved by enema the day after the operation. If the enema fails, calomel is given (gr. 3 or 4).

Digital Dilatation of Pylorus for Cicatrical Stenosis (Loreta's Peration, or Pylorodiosis).—Place the patient recumbent and adminster ether. Make a vertical incision in the linea alba or through the

right rectus muscle. The median incision begins one inch below the ensignation cartilage. The cut in either case should be five inches in length. When peritoneum has been opened, the stomach is drawn out of the wound, adherent omentum is separated, and the pylorus is carefully examined. stomach, after being surrounded with gauze pads, is opened near the centuits anterior surface, "but rather nearer to its pyloric end" (Jacobson).

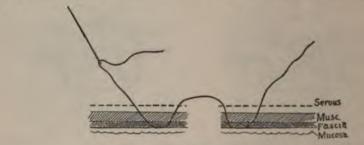


Fig. 543.-Lembert's suture.

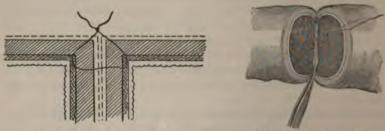


Fig. 544.-Lembert's suture closed.

Fig. 545.-Wolfler's suture.

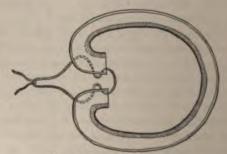


Fig. 546,-Gussenbauer's suture.

Insert the index-finger through the stomach wound and into the pylorus and follow that with the middle finger. The pylorus can be well dilated by separating the fingers. If the stenosis is so tight as to prevent the entry of softinger, first introduce a pair of hemostatic forceps and open the blades a little when they are within the lumen of the constricted area. The wound in the stomach is closed by a continuous silk suture of the mucous membrane and two layers of Halsted sutures, to invert and approximate the peritoneal surfaces. After closure of the stomach wound the abdominal wound is sutured.

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## **EXPLANATION OF PLATE 10**

Intestinal suture, all knots inside (Connell).

- a, Suspending loops 2, 3, and 4 are made with one thread inserted at a point two thirof the distance from mesenteric to convex border. The needle with suture is passes
  through the four walls of the cut ends, and that portion of suture within each lumen
  drawn up to a sufficient length, then cut, and the contiguous threads tied at the poinindicated by the arrows; thus having as a result four suspending loops dividing the cicumference of each cut end into thirds. Instead of employing four suspending loops
  which divide the circumference of the bowel into thirds, we may use but two loops, anthus divide the circumference into halves; or, if available, the "holder" devised by DE
  E. H. Lee can be recommended highly, and will be found a most efficient aid in maintaining the cut edges in apposition. (The description of the instrument will be found is
  the "Annals of Surgery," January, 1901.)
- b, Loop 2 has been cut away, and loop t takes its place in one hand of the assistant with loops 3 and 4 held in the other hand, thereby bringing into apposition that portion of the walls to be included in the second third of the suture. The operator continue the suture to the points of insertion of loops 3 and 4, where again a back stitch is taken, to fix the suture and prevent a purse-string contraction of the same. The white elevation in the center of illustration, representing mesentery, shows that that portion of the intestinal wall not covered by peritoneum, at the mesenteric border, has been secured in the suture.
- e, The needle, after having entered the lumen, is passed out again on the same side inch distant; then over to the opposite cut end, where it is inserted from without in, and again emerges from within out, on the same side. This step—the taking of a bite—is repeated alternately on opposing margins until the necessary number of stitches have been inserted. It will be observed that when the needle enters the lumen the last time, it makes what might be termed a half-stitch, as it does not return again through the wall; but having reached the point where the suture was commenced, the free end and the needle end will complete the last stitch, when tied, on the mucosa. The needle at this point is then brought out of the lumen at the angle of wound alongside of the free end of the suture. The cross-over stitches are next carefully drawn up, thus bringing into contact the opposing serous surfaces at every point except where the suture ends still protrude.
- d, The eye-end of threaded needle is made to emerge alongside of the suture ends and is then withdrawn a little, which causes its thread to form a loop, through which the assistant passes the ends of the suture. The operator next withdraws the threaded needle, at the same time bringing with it the suture ends, and they present externally at the point of withdrawal of the needle. The serous coats throughout the entire circumference are now in apposition, and the suture ends can be tied.
- e, By slight traction on the suture ends the opposing mucous surfaces are brought in close contact; the suture ends are then tied firmly, and deep between the serous coats, thus tying the knot upon the mucous coat, and the ends then cut off short.

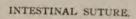
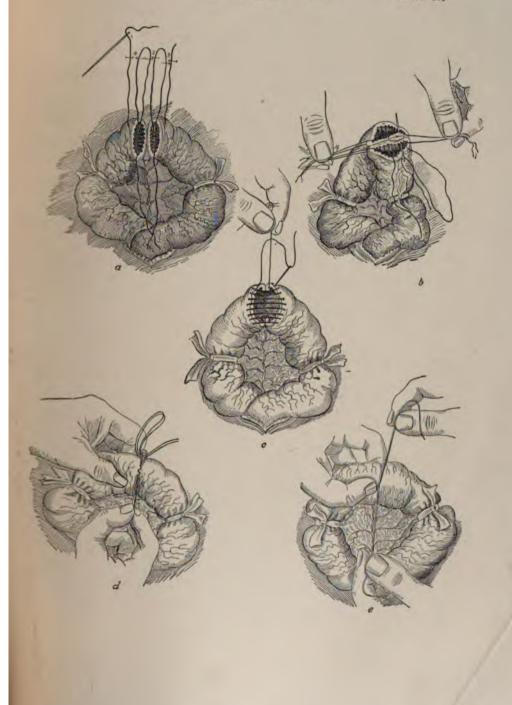


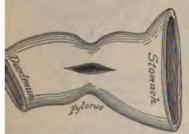
PLATE 10.





Divulsion by the fingers or by an instrument is no longer practised, because erience has shown that the constriction is sure to return.

Pyloroplasty (Heineke=Mikulicz Operation).—The first operative was performed by Heineke in 1886. Early in 1887 Mikulicz, not knowed Heineke's antecedent operation, did the same thing. Open the abdomin the middle line, or, better, through the right rectus muscle. Draw the pylorus as well as possible, and pack warm moist gauze pads around it; and in a direction corresponding to the axis of the stomach and bowel (Fig. 547). Catch an aneurysm-needledler the upper margin of the incision and draw it up, and an aneurysm-needledler the lower margin and draw it down. The effect of traction is to convert transverse wound into a vertical one. The sutures are applied so as to



3. 547.—Heineke-Mikulicz's pyloroplasty: the incision.

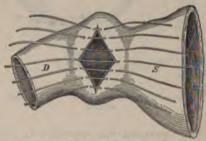


Fig. 548.—Heineke-Mikulicz's pyloroplasty. The axis of the incision is changed by traction from horizontal to vertical; sutures in position; only one of the two rows of sutures is shown.

intain the wound in a vertical line (Fig. 548). The mucous membrane is ured with a continuous suture of silk, and interrupted Lembert or Halsted ures of silk close the peritoneal and muscular coats (Figs. 548 and 549). in fortwenty-four hours, because there is danger of leakage. A. W. Mayo

bson inserts a bone bobbin and applies the sutures. The opern of pyloroplasty shows a morty about the same as or slightly
than gastro-enterostomy. In
c cases it is a very satisfactory
cedure, but there are objections
t, and in 30 per cent. of cases it
to give relief (Wm. J. Mayo).
outlet is not at the most depenpart of the stomach, hence the
nach may not empty itself. Furn, as Finney points out, it cannot
performed if there are firm adhe-

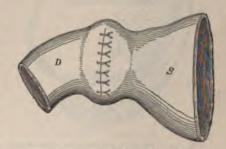
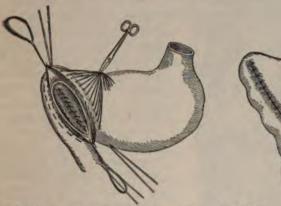


Fig. 549.—Heineke-Mikulicz's pyloroplasty: after tying the sutures.

ain, it is difficult to suture so as certainly to provide against leakage. The yos reported 21 pyloroplasties without a death, but 7 cases required condary operations ("Annals of Surgery," Nov., 1905). Pyloro-

bleeding; excise as much scar-tissue as possible on either side of the incision, and trim off the redundant mucous membrane. Insert a continuous catgut suture on the posterior side of the incision and carry it through all the coats (Fig. 554). Straighten out the anterior sutures and tie them (Fig. 555). The Mayos report Finney operations with 4 deaths and 2 secondary operations (Wm. J. Mayo "Annals of Surgery," Nov., 1905).

The mortality is greater than after gastro-enterostomy, due probably to the eccessity of separating adhesions and setting the duodenum free. The opera-



554-Finney's pyloroplasty. The continuous posterior catgut suture.

Fig. 555.—Finney's pyloroplasty completed by tying the anterior sutures.

should be restricted to cases in which adhesions are not widespread and and in which the gastrohepatic omentum is of fair length. In properly ceted cases it is an excellent operation.

Pylorectomy (Excision of the Pylorus).—The removal of a porof the stomach is a partial gastrectomy, and pylorectomy is a partial



E- 556.—Billroth's method of pylorectomy.



Fig. 557.-Pylorectomy.

Sastrectomy in which the pylorus and also a portion of duodenum are

The experiments of Gussenbauer and von Winiwarter on dogs in 1876 lead them to suggest this operation. It was first performed by Péan in 1879. It was next performed by Rydygier in 1880. Billroth did the first successful Dylorectomy in 1881. The operation is usually performed for cancer, but some-

Figs. 556 and 557. In Mayo's method, after exposing the stomach ligate the gastric artery close to the stomach, tie the lesser omentum in several

segments close to the liver and divide it, and tie the pyloric artery. Apply two clamps to the duodenum and have them inch apart, and divide the duodenum by means of the

autery (Fig. 558).

Close the right end of the uodenum by means of a connuous catgut suture, remove re clamp, and invert the closed and by a purse-string suture ig. 559). Pass a hand from ove back of the stomach and the great omentum forward. Te the right gastro-epiploic ery close to the stomach. the left gastro-epiploic ary distinctly to the left of any arged glands in the great in several segments. Diide the great omentum, leaving



Fig. 559.—Pylorectomy by the Mayo method. End entum. Tie the great omen- of divided duodenum buried by a purse-string suture. Row of lock stitches inserted in stomach stump (Mayo).

enlarged glands attached to the portion of the stomach it is the intention remove. The stomach is to be divided to the left of all lymphatic glands which the cancerous region drains. The clamps are applied as shown Fig. 558. The stomach is divided between the clamps with a cautery, and as the division is being carried out catch the stump here and there with hemostatic forceps to prevent it slipping through the clamps. Slipping is disastrous and will cause leaking and entrance of air into the stomach, and entrance of air is apt to be followed by pulmonary difficulty.

A row of locking stitches is passed through all the coats of the stump. The stitches are tied and a second row is passed and tied (Fig. 559). The clamp is removed and the stump is buried by Cushing's right-angled suture or Dupuytren's suture. A gastrojejunostomy is then performed to the posterior wall of the portion of stomach which remains.

Such a patient is usually much dehydrated, and if he is, salt solution should be given intravenously during the operation, and an enema of warm salt solution should be administered every six hours for several days after the Operation. Active stimulation is usually necessary and 8 ounces of coffee should be given by rectum at the completion of the operation. The patient must be placed erect or semi-erect in bed as soon as the effects of the ether pass away. Twelve hours after operation begin to give small amounts of hot water by the mouth. Nourish by the rectum from four to six days, when fluid food may be given by the mouth, starting with small doses of albumin-water, and if this is tolerated, giving dessertspoonful doses of peptonized milk every hour.

Total Gastrectomy.—The entire stomach was first removed by Conner, of Cincinnati, in 1883. The first successful operation was performed by Schlatter, of Zürich, in 1897. Total gastrectomy will rarely be required, but in certain unusual cases it will be proper to perform it. In some cases the duodenal end can be sutured to the divided esophagus; in others it will be necessary to close the end of the divided first portion of the duodenum, and anastomose

the esophagus to the jejunum.

The cases suitable for total gastrectomy are those in which the entire viscus, or almost the entire viscus, is cancerous, the stomach being still freely movable, and the glands not so much implicated as to forbid attempts at removal. It is a remarkable fact, first demonstrated in Schlatter's case, that an individual can digest food very well without a stomach. This statement is true only if the stomach function has been gradually abolished by disease. During this period the functions of the stomach have been assumed to a greater or less degree by other parts. In a recent injury of the stomach complete removal would almost certainly be followed by death, as in such a case other parts would have had no chance to learn how to assume gastric duties. The reported cases of total gastrectomy show 10 deaths out of 27 cases, but, as Robson truly says, if all cases were reported, the mortality would probably be found to be 50 per cent.

Gastrotomy.—This term is used to designate the operation of opening the stomach for the accomplishment of some purpose, and immediately closing the incision in the gastric wall when that purpose is accomplished. Gastrotomy may be performed to permit of the removal of foreign bodies, of exploration of the stomach and its extremities, of divulsion of the pyloric orifice, of the treatment of bleeding, of an esophageal stricture, or a stricture of the cardiac orifice of the stomach, or of the removal of a foreign body lodged in the esophagus. The first case on record was in 1602 when Matthis removed from the stomach of a juggler a knife which had been accidentally swallowed.

The patient is prepared as for pylorectomy. The incision may be vertical in the middle line or identical with the incision for pylorectomy. If a large foreign body can be felt, the incision is made directly over it. When the peritoneal cavity is opened, the surgeon decides as to the point where the stomach is to be incised, and draws this portion out through the wound, packing gauze pads under and around it. The stomach is opened by means of scissors, the cut being at a right angle to the long axis of the viscus (Jacobson). Bleeding vessels are ligated with catgut. The purpose for which the stomach was opened is now to be carried out, the interior of the stomach and the surface of the extruded portion are irrigated with hot salt solution, the mucous membrane is sutured with a continuous suture of silk, and two rows of Halsted sutures are inserted. The abdominal wound is closed, drainage being employed for twenty-four hours.

Gastrostomy is the making of a permanent gastric fistula, through which opening the patient can be fed. Gastrostomy was first proposed by Egebert in 1837 (Keen), and was first performed by Sédillot in 1849. In 1875 Sydney Jones operated upon the twenty-ninth case and obtained the first recovery (Keen). Up to 1884 the estimated mortality was 80 per cent. At present the mortality in malignant cases is from 20 to 25 per cent., and

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in non-malignant cases from 8 to 10 per cent. Gastrostomy is employed in cases of esophageal obstruction or obstruction of the cardiac end of the



ig. 560.—Witzel's method of gastrostomy, ing application of sutures in wall of stomembedding tube obliquely therein.

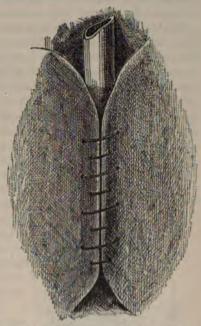


Fig. 561.—Sutures tied, completely embedding tube obliquely therein.

Tate, and if performed when the patient is greatly emaciated and exhausted,



Fig. 56z.—Kader's method of gastrostomy. Tube in place and first row of sutures inserted.



Fig. 563.—Kader's method of gastrostomy, First row of sutures tied and second row inserted.

the operation has, of course, a high mortality. An early operation is far safer and confers the maximum of relief. The operation should be per-

t is cone is puckered by the insertion of two drawing-string sutures of chromicized catgut through the serous and muscular coats. A cuff of gastrocolic omentum is sutured by silk around the neck of the puckered cone. The stomach sutured to the belly-wall with silk, the sutures including the omental cuff, the serous and muscular coats of the stomach, and the structures of the belly-wall, except the skin. The skin is partly sutured. The stomach may be pened at any time.

Gastro-enterostomy or gastro-jejunostomy is the establishment of permanent fistula between the stomach and the small intestine, in order side-track the pylorus. The operation is performed for cancer of the plorus, for non-cancerous stenosis of the pylorus, in some cases of ulcer the stomach, and for tetany. Anterior gastro-enterostomy was proposed

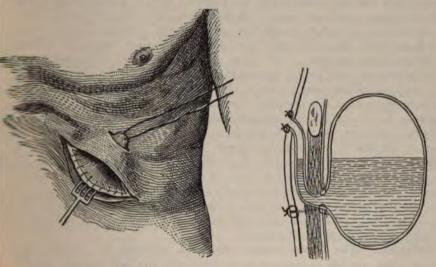


Fig. 565. Fig. 566.

Fig. 566.

The Ssabanejew-Frank method of gastrostomy in carcinoma of the esophagus.

In Wölfler's early operations the jejunum was so placed that the proximal end was to the right of the anastomosis opening. Hence peristalsis in the stomach was from left to right and in the jejunum from right to left, and this was supposed to be responsible for the common occurrence of regurgitant vomiting. It was sought to prevent this by altering the direction of the loop (Lücke), then by entero-anastomosis (Braun), and finally by a posterior anastomosis. Posterior gastro-enterostomy was first proposed by Courvoisier in 1883. His suggestion was that the posterior surface of the stomach be reached through the transverse mesocolon. His plan necessitated a transverse division of the mesocolon, but it was found that this impaired the blood-supply of a Part of the colon and might lead to gangrene. Von Hacker, in 1885, devised improved posterior operation. As a matter of fact, the transverse mesocolon has a marginal artery, unlike other parts of the colon, and the danger of

gangrene from a transverse incision is probably not very great. In the earlier operations by the posterior method a long loop was used and results were not notably better than after the anterior operation. In 1890 Czerny and Peterson advised the making of the jejunal opening close to the duodenojejunal flexure. The results from this operation are vastly better than from the anterior operation. Posterior gastro-enterostomy has been signally improved in technic by the Mayos, Moynihan, and others. In the earlier operations of anterior gastro-enterostomy the mortality was 40 per cent. In nonmalignant conditions the mortality after gastro-enterostomy is now very low (under 3 per cent.), the hyperacidity of the gastric juice disappears, and the functions of the stomach are restored. In malignant cases the mortality is about 20 per cent., but even in such cases, if operation is done early, life may be prolonged and made comfortable for months. Wm. J. Mayo makes the following report upon 421 cases of gastrojejunostomy: "Benign, 307 cases, 19 deaths (6.18 per cent.). In the last 140 there were 4 deaths, a mortality of 2.85 per cent.; the last 80 gave but I death. Malignant, 114 cases, with 21 deaths (18.5 per cent.). Of these 114 cases, 63 were in connection with pylorectomy and partial gastrectomy, with 8 deaths (12.6 per cent.). The very unfavorable cases of cancer obstruction were subjected to gastroenterostomy, so that this operation gives a higher mortality than radical excision. In the last 40 gastrojejunostomies for malignant disease the mortality was 8 per cent. In the 421 gastrojejunostomies there were 21 reoperated cases (5 per cent.)" ("Annals of Surgery," Nov., 1905). In about 5 per cent, of cases of gastro-enterostomy for benign disease secondary operation has been required. In Krönlein's clinic, 51 cases of malignant disease subjected to gastro-enterostomy showed an average duration of life of 102 days; 470 days after operation 17 cases were living. The causes of death, according to Mayo, are: exhaustion, exhaustion with vomiting, pneumonia, and detachment of the anastomosed intestine.

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Treatment After Gastro-enterostomy.—On returning the patient to bed at once establish continuous enteroclysis with one-half strength salt solution, the reservoir being only 6 inches above the level of the bed. This is Murphy's plan. As soon as patient is out of ether place him semi-erect. Mayo begins in from sixteen to twenty hours to administer by the mouth one ounce of hot water every hour, and if it is well tolerated, the amount is quickly increased, and in thirty-six hours liquid food is given and, if tolerated, is continued.

Complications Following Gastro-enterostomy.—Among them are lung complications. These are not due to the anesthetic, for they tend to occur even when local anesthesia has been employed. They are not due to the epigastric incision interfering with cough and expectoration, for they are not nearly so common after operations upon the gall-bladder (Wm. J. Mayo). Mayo says that the latest theory is that some of the venous blood returning from the stomach does not pass through the liver, and infected emboli are deposited in the lungs. The suture line may leak after gastro-enterostomy because of imperfect suturing, or the anastomosed intestine may become detached; 20 per cent. of the deaths among Mayo's cases resulted from this cause. Contraction of the anastomosis opening may gradually take

place. This has been held by some to be particularly common in cases of dilated stomach, shrinking of the stomach being the efficient cause; but evidence upon this point is not conclusive. In cases in which the pylorus is not obstructed shrinking often occurs, but it rarely takes place when the pylorus is obstructed. In some cases after operation a spur forms in the ejunum because of angulation; in other cases adhesions produce obstruction; and in rare instances ulceration takes place in the jejunum. The most common complication after gastro-enterostomy is persistent vomiting, which

ay or may not be expressive of the formation of a vicious circle.

Peplic Ulcer of the Jejunum.—The first case was reported by Braun in 2899. F. Gregory Connell has collected 38 cases and reported one of his own, in all ("Surg., Gynecol., and Obstet.," Jan., 1908). Connell points out at in many of the reported cases acute perforation occurred. Most of the ported cases, it is found, suffered from non-malignant trouble and had hyperad gastric juice. It very seldom occurs after operations for cancer. Most the reported cases happened after the anterior operation and when the astomosis was very near to the pylorus. It has happened, however, in o ses after the posterior operation, and cases have been reported following the anterior and posterior methods associated with entero-anastomosis. is probable that more cases seem to follow the anterior method because il late years it has been the operation commonly performed. In most of the orted cases the ulcer was single; in 3 out of 24 cases it was multiple. It is ally in the distal loop, but may be in the proximal loop. It may be situat the anastomosis level, a little way below it, or even 5 or 6 inches below The ulcer may appear a few days after the operation, weeks after, months after, or even years after. The condition results from hyperacid gastric juice passing directly into the jejunum before it has been neutralized by admixture bile and pancreatic juice. It is possible that the condition is predisposed by a twist in the jejunum and by such a small anastomosis opening that by peracidity was not corrected.

There may be no symptoms at all until there is a severe hemorrhage or perforation, or symptoms similar to those which called for the gastro-entermy may return. Connell's table shows that acute perforation took place in 14 of the 39 reported cases. In chronic cases treatment is first medical; if this fails, operation is indicated. In perforation, operation must be imme-

diate.

The Vicious Circle and Regurgitation.—Vomiting may occur after the performance of gastro-enterostomy. It may soon cease, may be productive of disastrous consequences, and may be expressive of an existing complication of great gravity. In some cases of gastro-enterostomy vomiting arises because the anastomosis has been made high up on the anterior wall and the stomach is not drained. In other cases ether induces vomiting, and the mechanical efforts force the contents of the duodenum and even of the jejunum into the stomach. The true "vicious circle" is a condition in which the contents of the stomach pass through the anastomosis opening into the duodenal side of the loop of intestine, mix with the duodenal secretions, and return to the stomach (Fowler, in "Annals of Surgery," Nov., 1902). The following conditions are often classified under the same head, but each is called by

Moynihan has confirmed these experiments by clinical obsebeen held that the cause of this condition is the making of with a long loop between the duodenojejunal flexure and opening into the jejunum, the loop being unable to propel it ward and tending by its weight to produce a bend or kink at tomosis. This is a very doubtful theory.

Persistent vomiting may be due to spur formation, which contents into the duodenal side of the loop. It is in some case



Fig. 567.—Gastro-enterostomy (after Lücke).



Fig. 568.—Implantat jejunum and jejunum Wölfler).

or twisting of the distal loop; in others, to failure of peristalsi loop; in still others, to contraction of the opening in the stomsky on Gastro-enterostomy in the Breslau Clinic; article by Clin "Annals of Surgery," Aug., 1908). I cordially agree with Herbert J. Patterson, viz.: "Most, if not all, fatal cases of regare due to mechanical obstruction at the afferent opening" Lectures delivered before the "Royal College of Surgeons of 19, 21, and 23, 1906). In order to lessen the danger of vomi

stomach-contents, and usually, but not always, pass into the efferent loop. In all these operations there is great danger of the development of a vicious circle.

Lücke devised an operation with the idea of preventing such a complication. In the Lücke operation the direction of peristalsis in the efferent loop is the same as in the stomach (Fig. 567). McGraw points out that the crossing of the loop which is effected is dangerous. The Wölfler-Lücke operation is shown in Fig. 577. Wölfler devised the operation pictured in Fig. 568. Von Hacker's posterior operation is thought by some to be less pt than the anterior method to be followed by the vicious circle (Fig. 578). Kocher devised an operation in which a valve is formed, but, as Fowler oints out, this valve does not prevent filling of the duodenum and imbiition of the material by the stomach; and, further, that the valve does not ork when the parts become cicatricial (Fig. 571).

The combination of gastro-enterostomy with entero-anastomosis does tend to prevent the vicious rcle. This operation is shown in Figs. 575 and = 76. I do not believe it should ever be a primary peration. It permits acid gastric juice to flow diectly into the jejunum and keeps away the bile which ould normally protect mucous membrane. Hence ch an operation exposes the patient to the danger Fig. 569.—Billroth's method jejunal ulceration. Another defect in such an cration is that there is still a communication be-



of gastro-enterostomy.

een the stomach and the efferent loop. Fowler's operation (Fig. 579) rects this defect. McGraw's operation (Figs. 572 and 573) tends to prethe formation of a vicious circle. It seems certain that the danger of the commation of a vicious circle is greatest after a long-loop anterior operation least after a short-loop posterior operation. The shorter the loop, the less the danger, hence the latter is the operation of choice. The safest operaof all is the short-loop operation of Moynihan or Scudder (page 1083), or "no-loop" operation of the Mayos (page 1086).

Treatment of Persistent Vomiting after Gastro-enterostomy.—If vomiting Persists in spite of gastric lavage and rectal feeding after the operation of Sastro-enterostomy with a long loop without entero-anastomosis, open the abdomen again and perform anastomosis between the afferent and efferent loops of intestine. This was suggested by Braun in 1892, and both he and Jaboulay performed it in the same year. The operation has saved lives. In a short-loop operation we should assume that the jejunum has been twisted, OPen the abdomen, and endeavor to correct the condition. Herbert L. Patterson (Ibid.) points out that slight cases of regurgitant vomiting not immediately following an operation may be due purely to constipation, and may be re-Covered from if care is taken to secure daily a free bowel movement. In Patter-Son's opinion constipation causes reversed peristalsis, and as both the duodenal siphon-trap and the pyloric sphincter are put out of service," regurgitation takes place from the efferent loop into the stomach.

Anterior Gastro-enterostomy.—Senn's Method.—A median incision is made through the abdominal wall, from below the xiphoid cartilage to the

## Diseases and Injuries of the Abdomen

An opening is made in the lower part of the anterior wall of the n the direction of the long axis of the viscus, and its edges are stitched ontinuous catgut suture. The contents of the jejunum are forced um should be from 12 to 14 inches in length. A rubber tube is fastened the bowel above this point, and another below it; an incision is made long axis of the bowel, and the margins of the wound are sutured in the long axis of the bowel, and the margins of the wound are sutured in the manner as the stomach-wound. Bone plates are introduced into the manner as the stomach-wound. Done plates are introduced into the lightness are tied as in intestinal anastomosis.

Mayo's Anterior Method (Fig. 570).—Open the abdomen, and pick up the Il intestine and find a point of jejunum about 14 inches from the point at ich it emerges from under the mesocolon. Effect the union to the inferior border of the stomach close to the greater curvature and



Fig. 570.—Mayo's method of gastro-enterostomy, showfig. 576.—Mayo's method of gastro-enterostomy, showing proper and improper locations of openings: a, Proper poing proper and improper locations of openings: a, respect position, leaving no pouch; b, usual position, forming intragastric pouch ("Annals of Surgery").

at the lowest portion of the When the anastomosis is completed, stomach pouch. the stomach pouch is funnelshaped. The usual customer has been to place the opening higher on the anterior wall. It sometimes led le the formation of a pouch or the anterior wall, did nos drain the stomach, caused vomiting. After the performance of gastro-eng terostomy the edges of the omentum are caught upoeach side of the anastomos and are sutured to each other and to the stomach-wall on inch above the opening. T edges are then united toes \_\_\_\_\_\_h other in a downward dir tion for about three inches so as to form an apron over the anastomosis, yet not comnected with it. Catgue is used for suturing. If leak age occurs, the omentuzza is

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of he

adjacent and "available." If leakage does not occur, the omentum soors are turns to its normal position. (Wm. I. Mour in "Arraba Caraba aujacent and "available." It leakage does not occur, the omentum soot turns to its normal position (Wm. J. Mayo, in "Annals of Surgery," [2002] Kocher's Method (Fig. 571).—After opening the abdomen, lift up 1902).

omentum, pull up a loop of intestine, and find the point where the jejumum appears from under the managed on Colonia land the point where the omenium, pull up a loop of intestine, and find the point where the jejurnum appears from under the mesocolon. Select a loop sixteen inches from the origin of the jejunum and prepare to attach it to the stomach. leved that the intestine should be applied to the stomach in such a manner t the direction of peristalsis in the bowel must correspond to the direction the stomach-tide. This can be accomplished by having the proximal tion of gut to the left, and the distal portion to the right. The operation o be so performed that after its completion the stomach-contents pass the distal portion of the gut, and the intestinal contents do not tend to er the stomach. In order to accomplish this Kocher hangs the intestine to stomach-wall in such a manner that the proximal portion of the loop is terior and ascending, and the distal portion is anterior and descending,

bowel is hung to the stomach by a tinuous serous suture of silk, the ends which are left long. The intestine is ned by a curved incision, the conity of which is downward. The nach is opened so that the convexity the cut is upward. The valve-like tion of the bowel-wall is sutured to stomach below the incision in that The two openings are well apximated by sutures.

Operation by McGraw's Elastic ature (Figs. 572-574) .- The elasligature was introduced by Siltri in 1862 and was first used intestinal anastomosis by the same geon. McGraw perfected the opera- enterostomy: a, Places of posterior annular "Annals of Surgery," Feb., 1906). e operation may be anterior or poste-. The intestine and stomach are nular suture of the serosa; e, thread ends for ured together by Lembert stitches. e elastic cord, which is 3 to 5 mm. in

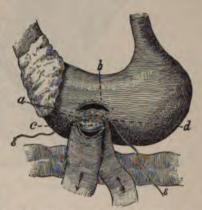


Fig. 571.-Kocher's method of gastroin 1891 (see Dudley Tait, suture through entire wall of stomach and intestine; b, places of anterior annular suture through the entire wall; c, valve at the jejunum by arch-formed incision; d, posterior ancontinuing anterior suture of the serosa,

meter, is passed through the stomach and then the bowel, in the long axis each, and is tightly tied, and the knot is fastened with a silk thread. Aner row of Lembert sutures buries the elastic cord from sight. The cord s through in from forty-eight to seventy-two hours and makes the anastosis. Thus the danger of infection is greatly lessened, for when the anastosis opening is formed, it is completely encompassed by firm adhesions. ther, the danger of the formation of a vicious circle is greatly lessened, ause there is no communication between the stomach and bowel for between y-eight and seventy-two hours, the period in which vomiting of the type viously described is most apt to occur. The method is not suitable for solute pyloric occlusion. In this condition it is imperative to give nourishnt early, and, again, an ordinary gastro-enterostomy allays autointoxication d this operation cannot until the ligature cuts through. It is particularly uable in the performance of lateral intestinal anastomosis.

Jaboulay's Gastro-duodenostomy.—This operation was devised by oulay in 1892. It aims to obviate some of the objections to pyloroplasty at the same time to retain the advantages this operation possesses over



Fig. 572.-McGraw's method of lateral anastomosis. The elastic ligature is introduced (Walker)



Fig. 573.—McGraw's method of lateral anastomosis. One tie of the elastic ligature with a strongilk ligature underneath ready to fasten the elastic ligature where it is drawn tant (Walker).

gastro-jejunostomy. Jaboulay's gastro-duodenostomy has never become popular with surgeons, and Finney's method is much more satisfactory (page 1066).

Posterior Gastro-enterostomy (Fig. 578).—In a thin subject with a long mesocolon posterior gastro-enterostomy is to be chosen, but if the mesentery is

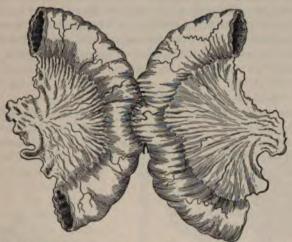


Fig. 574.-McGraw's method of lateral anastomosis. The operation completed (Walker).

short or contains much fat, or if the vascular loop coming from the superior mesenteric artery, and which supplies the transverse colon with blood, is small, so that on opening the posterior layer of the gastro-colic omentum it would be close to the artery, the anterior operation is employed (Wm. J. Mayo, in "Annals of Surgery," Aug., 1902). If a Murphy button is used, the posterior operation



Fig. 575.-Jaboulay's method of gastro-enterostomy.



Fig. 576.—Braun's method of gastro-enterostomy.

is selected. The operation is commonly performed as follows: After the abdomen has been opened, the stomach and omentum are raised; a portion of the upper jejunum is seized, emptied, and a site selected for the clamp. This site must be within 5 inches of the flexure. If there is a broad mesocolic band

preventing a near approach to the flexure the band must be divided. A class applied on the side opposite the mesenteric attachment. A spot is selected the transverse mesocolon where there are no vessels, and an opening is methrough the mesocolon with a dry dissector. The posterior wall of the stach is pulled into the opening and sutured to its edges. This prevents downward displacement of the stomach and obstruction of the loop of gut. portion of the posterior wall of the stomach is pulled out into a cone aclamped. Openings are made and the sutures applied as directed on pero83. Regurgitation is less common after posterior than after anterior gast enterostomy. In 250 posterior operations in Czerny's clinic there was not case of regurgitant vomiting. One hundred and seventy cases were buttoperations and 45 were by sutures alone (Peterson). Von Hacker had on instance of regurgitation in 60 posterior operations.

Operation by the Murphy Button.—Gastro-enterostomy may be quickperformed by the use of a large-sized Murphy button. Murphy says that
some reported cases the button has slipped back into the stomach, but the
accident can be prevented by the use of an oblong button and by making to
anastomosis on the posterior stomach-wall. The same surgeon advises us

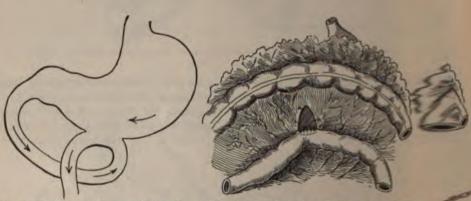


Fig. 577.—Wölfler-Lücke method of gastroenterostomy.

Fig. 578.—Von Hacker's posterior gastro-enteros tomy.

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scarify the peritoneum to hasten union, and says supporting sutures about the button are not required, except when considerable tension exists. There is no question that an anastomosis on the anterior wall, accomplished by a Murphy button, can be speedily performed. Anastomosis on the posterior wall cannot be performed so speedily, and it sacrifices to some extent the great advantage of the button operation—that is, speed. In spite of the reported cases we can positively assert that the danger of the button producing grave trouble is slight. In some cases it drops into the stomach and remains there, but seems to do no harm. In other cases it takes a long time to pass. In one of the author's cases it did not pass until the eighty-sixth day. If it does not pass in two or three weeks, the rectum should be explored with the finger from time to time to see if it is lodged there. The x-rays may determine whether

the button is in transit. If the wall of the stomach is thick, the incision should be made in the stomach-wall before the suture is passed, and this suture should pick up only a small portion of the stomach-wall, otherwise the button may be retained in place for a very long time (Wm. J. Mayo). "In many cases in which the button passes, vomiting with symptoms of obstruction may appear in the second or third week while it is in transit. Gastric lavage and rectal feeding for a day or two cause these symptoms to subside" (Wm. J. Mayo, in "Annals of Surgery," Aug., 1902). Mayo considers the suture operation as good as the button, and thinks the results are about the same. Mikulicz says that in the suture

operation entero-anastomosis is necessary, but not in the button operation, because the button, while in place, prevents angulation. The last-named surgeon uses the button in malignant cases and the suture in benign cases. Czerny is an advocate of the button. Every button should be tested before it is used. Mayo finds nearly 20 per cent. of buttons imperfect and dangerous.

Fowler's Method (Fig. 579).—Anastomose the posterior wall of the stomach to the jejunum and do an entero-anastomosis between the afferent and efferent loops of jejunum. Pass a No. 20 silver wire two or three times

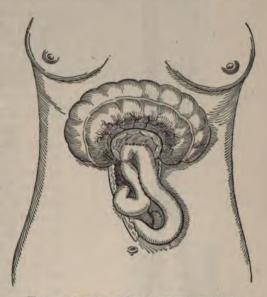


Fig. 579.—Fowler's method of gastro-enterostomy.

around the afferent loop of jejunum and draw it sufficiently tight to occlude the lumen without strangulating the wall of the gut. The ends are twisted, cut short, rolled into a flat coil, the cut ends being in the coil. (See Geo. Ryerson Fowler on the "Circulus Vitiosus" following gastro-enterostomy, "Annals of Surgery," Nov., 1902.) This operation positively prevents the entrance of material from the duodenal loop into the stomach and also drains that loop.

Moynihan's Method.—This is the plan I usually employ. It is easy, rapid, and clean: Make a 4-inch incision I inch to the right of the middle line and above the umbilicus. Open the anterior sheath of the rectus and separate it from the front of the muscle as far as the middle line. Draw the entire muscle outward, open the posterior portion of the sheath, and then open the belly. Inspect and feel the entire stomach. Lift the omentum and transverse colon out of the abdomen and make the mesocolon taut by raising the stomach and colon with the left hand. Find "a bloodless spot in

the arch of the middle colic artery," pick up a bit of the under surface of mesocolon with a pair of hemostatic forceps, lift it from the posterior stor wall, and open the lesser sac of peritoneum with the scissors. Enlarg opening by dilatation or tearing until it admits three fingers. Inspectively the posterior stomach-wall. Place the stomach in its natural posmark with the thumb the lowest part of the posterior stomach-wall

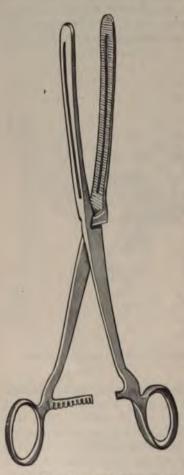


Fig. 580.—Moynihan's clamp for gastric and intestinal operations (made by Down Brothers, London)

again turn the viscus over. From spot marked by the thumb a fold is r The fold is oblique and its upper is to approach the cardia and curvature. A stomach clamp (Fig having a rubber tube bent over blade is applied obliquely so as to the base of this fold. ing the clamp the tip should point right shoulder and the handle t outer side of the left hip, and the l portion of the stomach is grasp the tip of the blade of the clamp 581). The clamp is now put in a zontal position. The duodenoje flexure is found with the finge jejunum is identified and its na position is noted. The jejunu picked up and "drawn tight" and : is noted which reaches the greater ture of the stomach when the jej is in its natural position. The noted is 5 inches from the flexure the jejunum above the spot is the anastomosis is made. The is applied in the side of the gut site the mesentery. The surgeon be sure that the jejunum is not to around its longitudinal axis. If the clamps are not rightly applied they must be placed so that afte anastomosis the jejunum lies natural position without a twist. clamped gut is placed by the side clamped stomach, a bit of gauze put between them (Fig. 582). The ach (except the clamped portion

omentum, and transverse colon are returned to the abdomen and the clare surrounded with gauze. Each clamp holds a fold 3½ to 4 inches in le Pagenstecher's celluloid thread is used for suturing. The first line of st is passed as shown in Fig. 583. In front of these sutures an incision is into the stomach and jejunum, the serous and muscular coats being first direction.



Fig. 581.-Moynihan's method of gastro-enterostomy. The oblique application of the clamp to the stomach (Moynihan).

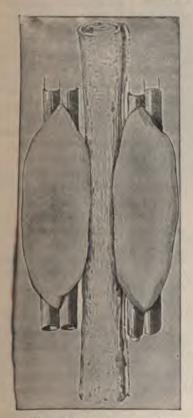


Fig. 582.—Moynihan's method of gastro-enterostomy. The strip of gauze between the clamps (Moynihan).

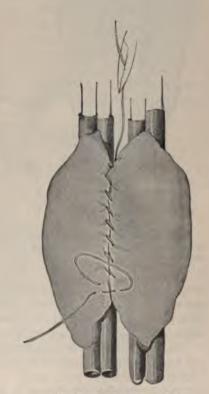


Fig. 583.—Moynihan's method of gastro-enterostomy. The first layer of serous suture (Moynihan).

and an ellipse of mucous membrane being removed (Fig. 584). The next row of sutures is inserted as shown in Fig. 585. When this row is completed the clamps are removed and the long suture of the first row is picked up again and the operation is completed (Fig. 586). Finally, the edges of the mesocolic opening are sutured to the jejunum. The parts are cleansed with salt solution, the suture line is inspected, the parts are returned to the belly, and the abdomen is closed. (See Moynihan's "Abdominal Operations.")

The No-loop Operation of the Mayos.—(Figs. 587-589).—In this operation the gastric opening, which is placed in the line advised by Moyni-

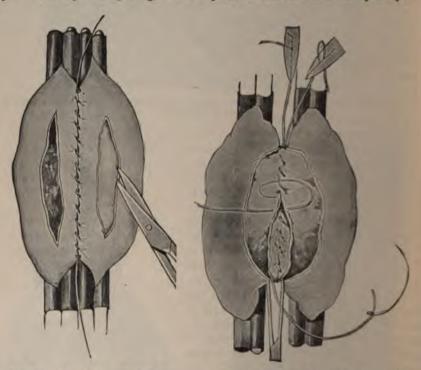


Fig. 584.—Moynihan's method of gastroenterostomy. Removal of the ellipse of mucous membrane (Moynihan).

Fig. 585.—Moynihan's method of gastro-enter ostomy. The inner suture, continued (Moynhan).

han, extends one-fourth or one-half inch into the anterior wall of the stoma and thus the lowest part of the opening will be the lowest part of the stoma (Fig. 587). The incision in the intestine begins from 1 to 3 inches from origin of the jejunum, the measure being made on the anterior surface (Fig. 58

The object is to get as short a piece of jejunum as can be attached wit out tension. The operation is described as follows (Wm. J. Mayo "Annals of Surgery," Nov., 1905).

"(a) The abdominal incision is made 4 inches in length, † inch to the right of the middle line, the fibers of the rectus muscle being separated. The lower end of the external wound lies opposite the umbilicus. This opening

also enables inspection of the duodenum and gall-bladder and is reliable against hernia when closed.

"(b) The transverse colon is pulled out and the mesocolon made taut by traction upward and to the right, in this manner bringing the jejunum into wiew at its origin.

"(c) About 3 to 4 inches of the jejunum opposite the mesentery are drawn into a slightly curved lamp. The handles of the clamps should be to the right, to enable a short grasp on the intestine. Three-fourths of the circumference of the bowel is sulled through; the posterior border is not insuded, to prevent entanglement of the suture in the redundant posterior mucous membrane. The holding clamps are applied sufficiently to check hemorrhage and prevent extravation of intestinal contents.

"(d) The ligament of Treitz is a short muscular sentery covered by a variable peritoneal fold o variable for a reliable landmark) extending vard from the origin of the jejunum on to the socolon. This peritoneal fold lies at the base the arterial loop of the middle colic artery which plies the transverse colon. The mesocolon is ned within the vascular loop and the pos-



Fig. 586.—Moynihan's method of gastro-enterostomy. The serous suture resumed (Moynihan).

or inferior border of the stomach pushed through. A small separation he greater omental attachment to the stomach enables the anterior gas-



Fig. 587.—Mayo's method of gastro-enterostomy. Showing posterior wall of the stomach drawn through a rent in the transverse mesocolon. Note slight separation of gastrocolic omentum from its attachment to the stomach, permitting anterior wall of stomach to appear, and insuring drainage at lowermost level. Black lines mark site of proposed anastomosis; the jejunum shows at its origin.

## Diseases and Injuries of the Abdomen

rall to be drawn out posteriorly. The posterior gastric wall is drawn a clamp, with the handles to the right, in such a manner as to just exthe anterior wall at the base.

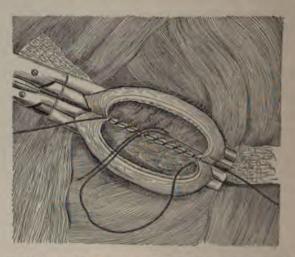


Fig. 588,—Mayo's method of gastro-enterostomy. Forceps in place and anastomosis half complete by suture.

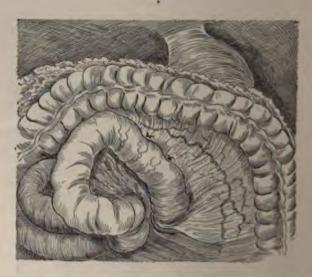


Fig. 589.—Mayo's method of gastro-enterostomy. Completed operation from behind margin of mesocolon attached by several interrupted sutures to line of union.

"(e) The two clamps are laid side by side and the field carefully protected by moist gauze pads. With fine celluloidal linen thread on a straight needle the intestine is sutured to the stomach from left to right by a Cushing suture at least 2½ inches.

"(f) The stomach and intestine are incised & inch in front of the suture ine and the redundant mucous membrane excised flush with the retracted peritoneal and muscular coats. With a No. 1 chromic catgut on a straight needle the posterior cut margins of the entire thickness of the gastric and ejunal wall are united by a button-hole suture from right to left; at the extreme left the suture changes to one which passes through all the coats, of each side alternately, from the peritoneal to the mucous, then directly back on the same side from the mucous to the peritoneal. This acts as a hemotatic suture, and also turns the peritoneal coats into apposition. It passes round the anterior surface and is tied to the original end, which has been left long for the purpose. If silk or linen is used for this suture, it may hang the situ, suppurating for months.

"(g) The clamps are now removed and the linen thread continued around mill it is tied to the original end, firmly catching the blood-vessels in sight long the suture line. The parts are carefully cleansed and inspected. If

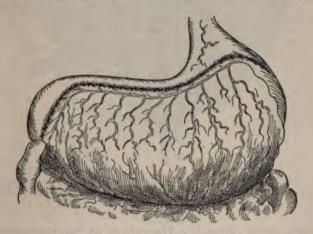


Fig. 590. -Bircher's method of gastroplication.

cessary, a suture or two is applied to accurately coapt or to check the ing.

\*(h) The margins of the incised mesocolon are now united to the suture by 3 or 4 interrupted sutures, and the parts returned into the abdomen."

this operation the greatest care must be taken to avoid twisting the gut bund its longitudinal axis.

Gastro-anastomosis or gastrogastrostomy is an operation perremed for hour-glass contraction of the stomach, a condition which occaonally ensues on the healing of an ulcer. In this operation an anastomosis effected between the pyloric and cardiac pouches. It was devised nd practised by Wölfler in 1894. I have practised it twice with success. Watson folds the two stomachs over each other, using the narrow isthmus as a hinge; sutures the pouches together and leaves the ends of the sutures long. He incises the anterior wall of the anterior stomach in order to obtain access to the double septum between the two pouches. He makes an anastomosis opening through the double septum, sutures the edges, and closes the wound

in

in the anterior wall of the anterior stomach. Wölfler made a vertical cut each pouch and united these openings to make an anastomosis. The best plis to apply clamps on each side of the isthmus and operate as we would gastro-enterostomy.

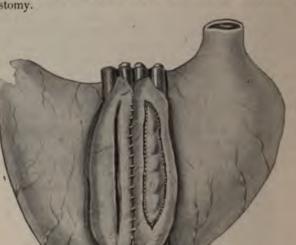


Fig. 591.—Hour-glass stomach. The application of clamps and the method of suture imgastrogastrostomy. The details are the same as in the operation of gastro-enterostomy (Moynlhan).

Gastroplication (Brandt's Operation of Stomach-reefing for Dilated Stomach).—Apply sutures in the anterior wall so as to form reefs, then tear through the great omentum and apply sutures in the posterior wall. The sutures pass through the serous and muscular coats. A continuous suture may be used on the anterior wall and another on the posterior wall, or numerous interrupted sutures may be inserted. This operation is of questionable value, and must never be used if stenosis of the pylorus exists, and stenosis of the pylorus is the most common cause of gastric dilatation.

Bircher's method of gastroplication is shown in Fig. 500.

Gastropexy (Duret's Operation for Gastroptosis).—It has been shown by Duret that dyspepsia of a peculiarly severe type may be produced by prolapse or downward displacement of the stomach. In this condition he advised the following operation: Perform a median laparotomy, but do not incise the peritoneum in the upper portion of the wound. Expose the stomach and fix it by means of a silk suture to the undivided but exposed peritoneum. The suture should be parallel to the lesser curvature and near the pylorus should be horizontal.\* The operations of Duret, of Rovsing, of Hartman, and

of Eve, of London, fix and distort the stomach. This seems to me an objectional procedure and liable to be followed by pain. To fix an organ which undergoes active peristalsis must surely be productive of difficulty. Byron Davis advises the suturing of the gastrohepatic omentum near its attachment to the lesser curvature to the stomach-wall as high as possible. Beyea has devised an operation which is free from the objections which may be urged against Duret's operation.

Beyea's Operation for Gastroptosis.—Insert three rows of interrup ted silk sutures through the gastrohepatic omentum and the gastrophrenic ligament. Each suture is passed from above downward and the row begins at the right and passes to the left (Fig. 592). When the sutures are tied, a fold

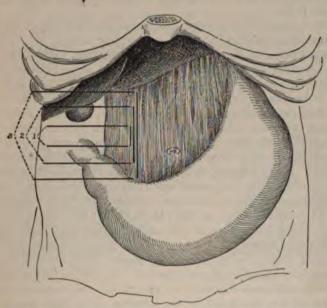


Fig. 592.—Beyea's operation for gastroptosis: 1, Position of one suture of first row; 2, one suture of second row; 3, one suture of third row. Others of each row introduced at intervals to and including the gastrophrenic ligament.

or plication is formed in the ligaments, the supports of the stomach are shortened, and the viscus is elevated to a normal position without any disturbance of its physiological mobility ("Univ. of Penna. Med. Bull.," Feb., 1903).

Duodenostomy and Jejunostomy.—It has been suggested that one of the above operations should be performed in a case of pyloric obstruction in which pylorectomy is not feasible. Duodenostomy is an easy operation because of the mobility of the pylorus and first part of the duodenum, and it is not only easier, but is safer, than jejunostomy, because it makes the fistula above the opening of the common bile-duct ("Bull. et Mém. de la Soc. de Chir. de Paris," No. 39, 1901). Cackove advocates the operation in some cases of gastric ulcer with repeated hemorrhages and some cases of gastric cancer. In the latter cases he asserts that the mortality is about the same as from gastro-

enterostomy and the prolongation of life is greater ("Arch. f. klin. Chin Bd. lxv, Heft 2). Hartman's case of duodenostomy lived two months. To operation was performed for extreme cicatricial stenosis of the pylorus dues swallowing hydrochloric acid. Moynihan points out that if the operation done at all, the indication for jejunostomy is cancer involving the entire stotach or leather-bottle stomach. He operated on 2 cases. One lived one month and one seven weeks (B. G. A. Moynihan, "Brit. Med. Jour.," June 1902).

Jacobson disapproves of both procedures, and objects particularly duodenostomy, because it involves a portion of the intestine which is difficto deal with, and because important fluids escape constantly from the fistula-

The same author objects to jejunostomy because of the inevitable leaks of nutritive fluids.

Reported cases of duodenostomy and jejunostomy certainly do not indicate that the operations prolong life to any considerable degree.

Enterectomy, or Resection of the Intestine with Approxim
tion by Circular Enterorrhaphy.—How much of the intestine can be
moved without the patient dying from lack of nutrition? The question is
settled. It has been stated that the removal from an adult of more than
and two-thirds feet produces intestinal disturbance, and that a child tolera
the removal of a piece relatively larger better than does an adult. Certa
it is that great lengths have been successfully removed, and the patients ha
not only lived, but have been well nourished. Ruggi removed eleven for
successfully. Hayes removed eight feet four and one-half inches from a b
of ten years of age, and the patient was well eight months later. Dressm
reported 26 cases in each of which more than three feet three inches had be
removed (Alexander Blaney, in "Brit. Med. Jour.," Nov. 16, 1901). Blandy
adds 7 cases from literature, and tells us that in 9 of the 33 cases death
curred soon after operation.

Alexander Blaney, in the previously quoted article, reviews the subject of the resection of great lengths of intestine. He tells us that how much mains after a resection is important but uncertain. It is uncertain because, as Treves has shown, the length of the intestine varies from fifteen feet inches to thirty-one feet ten inches.

Resection of the jejunum is much more dangerous than resection of equal length of ileum. If resection is employed, all diseased or injured bow must be removed irrespective of ultimate bad consequences (Blaney). The operation is performed as follows: After opening the abdomen isolate the loop of intestine we intend to resect. Push a rubber tube through the mesentery close to the bowel, above the seat of operation, and pass a rubber tube through the mesentery below the seat of operation. Empty this segment of bowel by squeezing and stroking, tighten the rubber tubes, and clamp them to keep the bowel empty (Fig. 593). Instead of tubes, strips of iodoform gauze may be used to encircle the bowel. The diseased intestine is resected, each incision being carried through a healthy segment, and care being taken that the cuts are so arranged that at each end a blood-vessel from the mesentery reaches the edge of the cut bowel. Otherwise repair can scarcely

occur. The lumen of each end of the divided gut is irrigated with salt solution. The divided surfaces are approximated by a double row of sutures—a continuous suture for the mucous membrane, and Lembert's, Dupuytren's, or Cushing's suture to effect inversion. Thoroughly satisfactory approximation can be effected by one row of Halsted sutures. If a redundant fold of mesentery is left, it can be stitched at its raw edge (Fig. 594). Many surgeons remove a V-shaped piece of mesentery and tie the divided mesenteric vessels (Fig. 593). The tubes are removed, and the wound is cleansed, closed, and dressed.

Senn effects invagination by means of a bone ring (Fig. 597).

If the two segments of bowel are unequal in size, the narrow part of the bowel should be cut obliquely and the larger part should be cut transversely. To meet this complication Billroth devised lateral implantation (Fig. 626). Suppose the cecum has been resected; its lower end is closed by Lembert sutures, an opening is made in the long axis of the periphery of the colon opposite the attachment of the mesocolon, and the end of the ileum is sutured into this incision. This is called end-to-side approximation, or implantation. It is used in the sigmoid, in the cecum, and in any intestinal segment in which the circulation is deficient. Eugene A. Smith ("Amer. Med.," May 10, 1902)



Fig. 593. —Excision of bowel; first step (Esmarch and Kowalzig).



Fig. 594.—Excision of bowel with enterorrhaphy and stitching of the redundant mesentery; second step (Esmarch and Kowalzig).

sums up the advantages of end-to-side approximation as follows: The strain of peristalsis is less than in end-to-end union; the circulation of each end of the bowel and the parts of bowel adjacent is better; each cut edge of mesentery is free to recover its circulation, and there is no dead space at the mesenteric border to lead to leakage.

Senn advises the insertion of an anastomosis-ring in the ileum, the invagination of the colon as the ring is pulled into place, and firm suturing of the line of junction. By Senn's method the ileum may be implanted into the end of the colon or into a slit in the wall of the large bowel after the end of the colon has been closed. In some cases, where one portion of bowel is larger than the other, lateral anastomosis is the preferable method. For a full week after an intestinal resection the patient is fed chiefly by nutrient enemata. During the first twenty-four hours nothing is given by the stomach but small amounts of hot water, and for the next six days but a little liquid food is allowed to be swallowed.

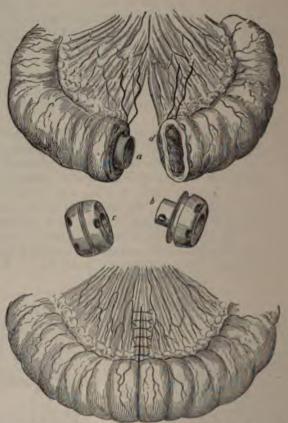


Fig. 595.—Resection of intestine: a, b, The two halves of the button; c, the two portions clamp-together; d, introduction of the sutures for holding each half of the button in place. The low figure shows the completed union of the intestine by the Murphy button; the slit in the mescale has been closed by linear union (after Zuckerkandi).



Fig. 596.—Comparison of old (a) and new (b) Murphy buttons.

se of Murphy's button permits of rapid approximation after resection



Senn's modification of Jobert's invagid: A, Upper end lined with ring; B, sutures in place; C, lower end.

(Fig. 595, b and c). This button closely approximates the portions of the intestine within its bite, rapid adhesion taking place. The diaphragm of tissue undergoes pressure-atrophy and liberates the button, which is passed per anum. It is claimed that the button-opening contracts but slightly. For end-to-end or side-to-side approximation of the small intestine a No. 3 button is used. For similar operations on the large intestine a No. 4 button is employed (Murphy). After the resection one half of a but-

erted into each segment, and is held in place by a purse-string suture ich passes through all the coats (Fig. 595). The redundant mucous

is tucked in or f, so that it will erposed between surfaces. The urfaces are with a needle alves of the butcked (Fig. 595). ecessary to surmargin of juncsutures. Murhat liquid nourhould be given the patient has from the effect er, and that the ould be moved rly period, and evacuations maintained. If does not pass eks, examine the it.\* The situae button can be d by the x-rays. ion to the butt it introduces a dy which must

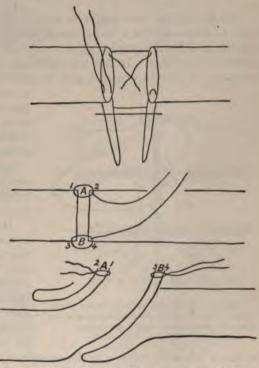


Fig. 598.-Maunsell's method of anastomosis (after Wiggin).

ectum to complete the operation successfully. It may not pass, but

\* John B. Murphy, in Med. News, Feb. 9, 1895.

trouble does not of necessity follow. But in some cases its retention lead trouble, and obstruction ensues. If the caliber of the button blocks be dislodgment, obstruction follows; hence the rule to give saline purgation the day after the operation.

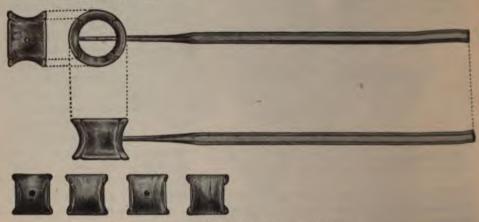


Fig. 599. -The segmented ring of Harrington and Gould.

Some surgeons have sought to make a button which would come appeared and be absorbed after it had accomplished its purpose. The best of the appliances is Frank's coupler, which is made of bone, the compression being furnished by rubber. In this apparatus, however, the amount of pressur obtained is always uncertain and the rubber is apt to wear out. The

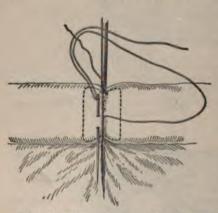


Fig. 600.—End-to-end union with aid of segmented ring. Continuous stitch beginning at one side of the handle (Harrington and Gould).

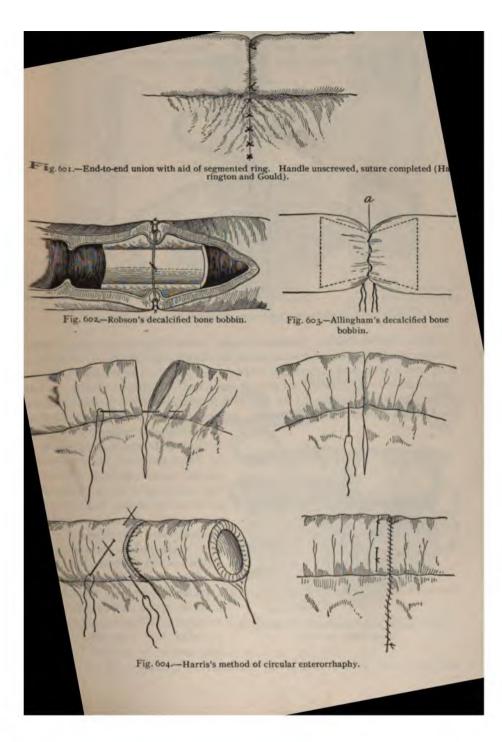
button gives a lower mortality that the suture operation, and many surgeons now use it who once condemned it. Czerny is a strong advocate of the button.

After intestinal resection Halsted performs circular enterorrhaphy by means of mattress sutures (Figs. 605 and 606).

Harrington and Gould use a segmented aluminum ring. This ring collapses into small segments after the anastomosis has been effected. By its use the authors believe that the operation is made more rapidly and safely ("Annals of Surgery," Nov., 1904). During the suturing the ring is held by

means of a handle, which, after the anastomosis has been effected, is removed. The ring in the handle is shown in Fig. 500 and the operation in Figs. 600, 601.

Maunsell has devised a most ingenious method of circular enterorrhaphy. The two portions of bowel are attached by two fixation sutures which penetrate all the coats (Fig. 598). An incision one and one-half inches in length is made



through the wall of the proximal segment of gut, about one inch from its dge. The fixation sutures are brought through this opening, traction is made pon them, the distal portion of the bowel is invaginated into the proximal por and the ends emerge from the opening, their peritoneal surface being in contact (Fig. 598). Sutures of silk are passed through both sides of the of invagination, the threads are caught up in the center, cut, and tied on side. The fixation sutures are cut off. The invagination is reduced by traction. The longitudinal cut is closed by Lembert sutures.

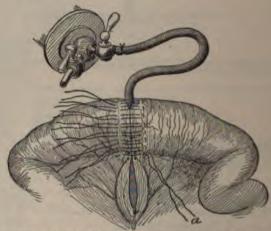


Fig. 605.-Use of Halsted's inflated rubber cylinder in circular enterorrhaphy.

A. W. Mayo Robson performs circular enterorrhaphy and brings ends of the gut together over a bobbin of decalcified bone (Fig. 602). Alliham uses a bone bobbin the shape of two cones joined at their apices. The bobbin is decalcified, except an area at the center (Fig. 603). Kocher performs circular enterorrhaphy as follows: A fixation suture is introductionally the bowel at the mesenteric attachment and another is inserted.

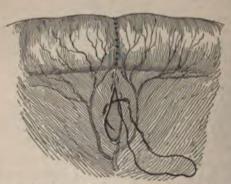


Fig. 606.—Suture of the mesentery after circular enterorrhaphy (Halsted).

at an opposite point. The is testinal ends are approximate by a continuous silk suture which passes through all the coats, but which include more of the serous than of the mucous coat. The suture-line is overlaid by a continuous Lem bert suture which includes the serous and a portion of the muscular coat. Harris removes a portion of mucous membrane from the distal end by means of Three needles are a curet. threaded with fine silk. first needle is pushed through

the bowel-wall to one side of the mesentery. The point of the needle

the ng-

ed ed n-d



Fig. 607.—Moynihan's thod of end-to-end anasmosis (Moynihan).



Fig. 608.—Moynihan's method of end-to-end anastomosis continued.



Fig. 609.—Moynihan's method of end-to-end anastomosis continued.

ks up a portion of the distal end transversely. The needle is used as a cer to invaginate the distal end into the proximal end. The same pro-

dure is carried out with e other needles. When vagination is effected the edles are pulled through d the threads are tied. The end of the bowel is now tured to the invaginated of the invaginated tures or by a continuous version suture broken once ig. 604).\*

In doing an end-to-end Proximation I prefer to the clamps of Moynihan, shown in Figs. 607, 608, and 609. We thus are able hold the parts and keep

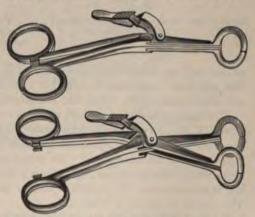
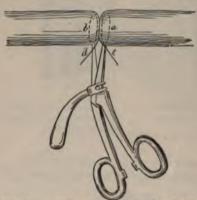


Fig. 610.—Laplace's forceps for intestinal anastomosis.

hem clean, rapidly make an even and secure stitch line, and have no freeedged septum.

\* Chicago Med. Recorder, Jan., 1897.

Some surgeons employ inflatable rubber cylinde anastomosis (Halsted, Downes, and others). The Treves, but was subsequently abandoned by him the use of the inflatable rubber cylinder enables the tion more quickly and to dispense with clamp motion of the intestine; makes easy the adjuncted of unequal size; and renders it por rapidly, evenly, and securely.\* Three presection portion of bowel and a V-shaped piece of mes mesenteric incision being so made as to leave edge to supply each end of the divided intestine. are ligated and the ends of the bowel are pulled stitches, two of which are tied. The collapsed reinto the bowel by means of forceps and is inflated. Twelve mattress sutures are inserted, the



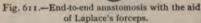




Fig. 612. Senn's bone poperation con

drawn and the sutures are tied, the stitch a be. The slit in the mesentery is sewed in such a way sels which nourish the bowel are not interfered to

Connell has devised a method which places the bowel (F. Gregory Connell, "Medicine," April, the placing of the knots within the lumen of the greages: there is no foreign body; the suture passes neighboring organs are few; the serous approximation is more secure; the septum is smaller and the The suture is shown in Plate 10.

Laplace has devised forceps which greatly facil it easy to obtain an even suture-line, and which c suturing is finished, the small opening through whi being closed with a stitch (Figs. 610, 611). By a operation can be neatly and rapidly performed,

\*Phila. Med. Jour., Jan. 8, 18

med, a considerable area is exposed to infection, the tissues of the diaragm are bruised and may slough, the raw ends may grow together and

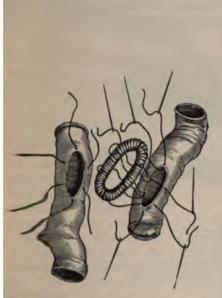


Fig. 6 1 3.—Method of passing the silk sutures in inserting the rings of Abbe.



Fig. 614.—O'Hara's anastomosis forceps (about one-third original size).

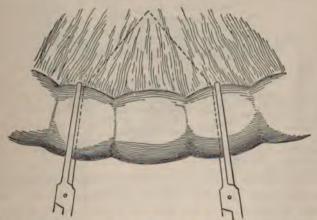


Fig. 615—Showing the manner of placing forceps in resection of bowel; dotted lines show the incision to be made (O'Hara).

cause obstruction, and it seems probable that considerable contraction will follow. Another objection is that an infected instrument is withdrawn from the bowel and may contaminate the peritoneum. O'Hara's forceps (Fig. 614) permit

of rapid and accurate suturing, but possess the same disa Laplace forceps. In one case within my knowledge abs from adhesion of the raw edges of the septum followed its em 615 and 616 show the use of O'Hara's forceps. Of the ously set forth, I prefer the clamp and suture as employe

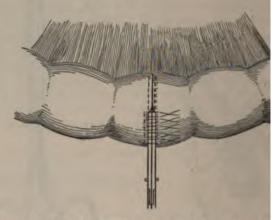


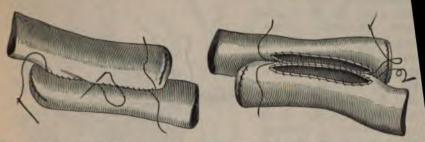
Fig. 616.—End-to-end anastomosis. Forceps brought together and held by a sutures introduced, some of which are tied (O'Hara).



Fig. 617.—Showing relative size of incision and method of introducing sutures tion with Murphy's button.

the operation of Halsted (although distention by an inflate a necessary adjunct), or the operation with the Murphy bu

Lateral Intestinal Anastomosis.—Approximation m other methods than by end-to-end junction or implantation fer in most cases of resection to close each end of the diviform lateral anastomosis. By this operation we can obto opening as we desire. Again, after lateral anastomosis a better blood-supply than after end-to-end suturing, because in the form



ig. 618, -Suturing intestines in apposition be- Fig. 619.-Showing the four-inch incision and sewfore incision (Abbe). ing of the edges (Abbe).

peration the mesenteric vessels are not interfered with. Further, in lateral

astomosis there is little endency to cicatricial contraction. Lateral anasto mosis may be performed some cases without a preliminary resection for the Purpose of short-circuiting the fecal current, throwing a diseased portion of the bowel out of action, and thus avoiding obstruction (Fig. 612). This operation has the disa d vantage that the diseased structure is not removed.

Operation with
gs.—In this operation
a Portion of bowel above
the obstruction and a loop
below the obstruction are
ught into the wound.
These segments are empticed, and are kept empty
by fastening around them
rubber tubes or iodoform

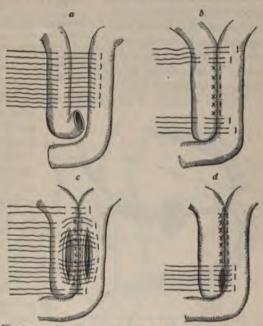


Fig. 620.—Halsted's operation for lateral anastomosis, showing four steps of same (Jessett, from Halsted).

Make an incision in one loop, in the long axis of the bowel, on the surface away from the mesentery, permit the contents to escape externally; irrigate this segment with saline solution; and introduce the bone plate of Senn (Fig. 612, A) or Abbe's catgut ring (Fig. 613). Calyx-eyed needles are used to pass the silk, and the threads of the ring are carried through the coats of the bowel and are gathered together in the bite of a pair of forceps. The other loop of intestine is treated in a similar manner. The two segments of intestine are so brought together that the two wounds are opposite each other, the posterior

sutures being tied first, the upper next, then the lower, and finally the ant

threads. The ends of the threads are cut off and the entire anastomosis is surrounded by a layer of Lembert or Halsted sutures or is encircled by Cushing's suture. Fig. 612, B, shows an intestinal anastomosis partly finished, and Fig. 612, C, shows an anastomosis complete. Fig. 613 shows the passing of the sutures when the catgut rings of Abbe are employed. After an intestinal resection each end can be closed and anastomosis effected as described above. Lateral anastomosis can be accomplished with a Murphy button, the intestine being prepared for the button as is shown in Fig. 617.

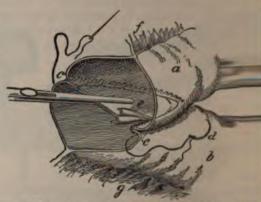


Fig. 621.—Represents the ends of the intestine in tion and grasped by the artery forceps. The first rosutures has been partially applied, the septum partial away, and the second row of overhand sutures a, b, are the two ends of the intestine; c, c, the first rosutures (Cushing); d, the second row of sutures (Sushing); d, the second row of sutures (Sushing); e, the septum; f and g, the mesentery (J. Shellow Horsley).

Abbe's method of anastomosis without mechanical aid is as follows:

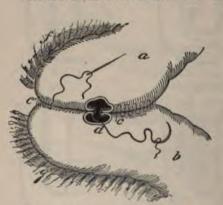


Fig. 522.—Operation nearly completed. The septum has been cut away, and the row of overhand sutures has been brought almost to its point of commencement. The cut also shows the first row of sutures (Cushing) as it should be continued after the overhand sutures are finished (J. Shelton Horsley).

After resecting the bowel and mesentery and closing the ends of the bowel he places the extremities side by side and applies two rows of a Dupuytren suture, one-quarter of an inch apart. These rows of sutures are an inch longer than the slit in the bowel will be (Fig. 618). the thread at the end of each wow being left long. An incision is made in the bowel, one-quarter of an imich from the sutures, both rows threads being on the same side of the cut. This incision is four inc Ins long. The other portion of the bowel is then incised in the same way. The adjacent cut edges = ire united by a whip-stitch which through all the coats, and the cut edges are stitched in the sa ne

manner (Fig. 619). The surgeon now utilizes the long threads of the sutures, and brings the serous surfaces of the opposite sides together by means of Dupuytren's suture. Halsted performs anastomosis as follows: He plans the two portions of bowel with their mesenteric borders in contact. Sur quilted sutures of silk are introduced, tied, and cut off (Fig. 620, a).

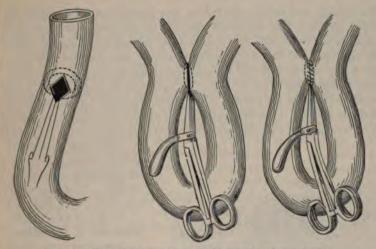


Fig. 623.—Lateral anastomosis with the aid of Laplace's forceps.

(Fig. 620, b). A number of quilted sutures are introduced, as is shown Fig. 620, c. The intestinal openings are made with scissors, and the ures last introduced are tied and cut off (Fig. 620, d).

J. Shelton Horsley has suggested an ingenious method of intestinal anasto-

sis which secures for the sued portion a greater diameter an that normal to the intese.\* After resection of the testine and a V-shaped piece of esentery, the ends of the bowel e placed side by side, the opens being in the same direction, d are clamped in place (Fig. i). The first stitch approxites the two limbs of the bowel ir the mesenteric attachment, carried obliquely for about inches to the border oppothe mesenteric attachment, continued over the other e (Fig. 621). The septum is away, a margin being left third of an inch wide. The

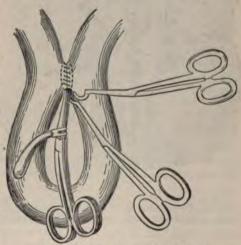


Fig. 624.-Withdrawal of Laplace's forceps.

e of the shelf made by cutting the septum is sutured. When the suture ches the end of the shelf, it is continued by invaginating about the rest the resected ends (Fig. 622).

Bodine's method of intestinal anastomosis is referred to on page 1112. place, of Philadelphia, has devised an operation in which temporary proximation is effected by means of forceps, the instrument being withway before the abdomen is closed. Junction of two segments of intestine

Laplace's forceps, O'Hara's forceps, the decalcified bone plates of Senn, the catgut rings of Abbe, the segmented ring of Harrington, the catgut strands inside of rubber tubing of Brokaw, Chaput's button, Allingham's bone bobbin, Robson's bone bobbin, Frank's coupler, Clark's bobbin, tubes or plates of potato or carrot, and rings or plates of leather, all have their adherents. Of mechanical appliances, the best are Murphy's button, the bone ring, Moynihan's forceps, and the inflatable rubber cylinder. Of recent years many surgeons have abandoned all mechanical aids, and have returned to closure by simple sutures. The ideal operation is without mechanical contrivances. But such devices are time-savers, and to lessen the time of operation will often save life. Further, Moynihan's forceps prevent fecal extravasation consequent infection. What method to follow must be determined in each particular case by a study of the necessities of the situation. Nevertheless, it may be possible to formulate a few general rules: If the condition of the patient is excellent and the bowel is in a fairly healthy condition, well

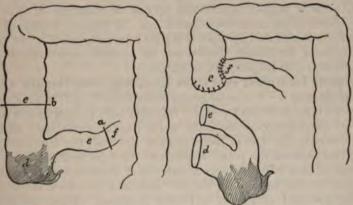


Fig. 626.—Operation of complete exclusion of the cecum: a and b, Lines of incision; f is implanted into c; e and d are sutured to the abdominal wall.

be performed by circular enterorrhaphy with the aid of Moynihan's clamp, or each end can be closed after resection and a lateral anastomosis be effected with the aid of the clamp. If the condition of the patient is such as to make haste necessary, use a Murphy button. If the bowel below the seat of trouble much contracted and haste is necessary, do not use a Murphy button, but seems bone plate or Robson's bobbin. If haste is not imperatively ecessary, do enterorrhaphy. If the surgeon is obliged to join a very much distended bowel to a very much contracted bowel, perform end-to-end approximation (implantation) with the bone plate of Senn or by simple suturing, else effect side-to-side junction by the method of Abbe or of Moynihan.\*

Local Intestinal Exclusion.—This operation was introduced by Salzer in 1891. It excludes the fecal current from a portion of the intestine. In complete exclusion the intestine is cut through above and below the diseased portion and the ends of the healthy gut are united to each other or the end of one portion of gut is implanted into the side of the other. Both ends

<sup>\*</sup>See the discussion of this subject by the late J. Greig Smith in his "Abdominal Surgery."

a bdominal wall as well as the omentum. The liver and spleen, under surface of the diaphragm, and parietal peritoneum about the liver and spleen are usually rubbed harshly with a piece of gauze. Drainage is not to be used. It does not appear to contribute any favorable chances and it exposes the patient to the danger of infection.

The operation ought to be performed early, before the onset of chronic inflammation of the peritoneum. In a great majority of cases the operation proves futile, and not uncommonly death soon follows from complications or because the disease is very far advanced. In exceptional cases the operation proves of distinct benefit. The operation shows the least mortality and the greatest number of apparent cures when the liver is large; the greatest mortality and the fewest cures when the liver is contracted. The greatly lowered vital resistance of these patients is the imminent danger (Greenough). Renal disease, cardiac disease, other grave complications, and the absence of sufficient functionating liver substance to maintain life contraindicate operation (Greenough, in "Am. Jour. Med. Sciences," Dec., 1902).

Harris, in the paper previously quoted, collected 46 cases. Twenty-three of these were instances of alcoholic cirrhosis. Thirty per cent. were dead within fourteen days; 52 per cent. were dead within two months; 56 per cent. were dead within six months. Ascites had returned in all of those who died late. At the end of one year or longer 13 per cent. had recovered from ascites. The remaining 30 per cent. were either unimproved or were said to be improved with some ascites.

said to be improved with some ascites.

Of the group of mixed cases constitut

Of the group of mixed cases constituting the remainder of those Harris collected, 10 per cent. were dead in four days, 25 per cent. were dead in four months. In 40 per cent. no improvement took place. In 10 per cent. the report was too early to give any information. About 15 per cent. were free of ascites after one year or longer, and 5 per cent. were cured of intestinal hemorrhage, ascites never having been present. Greenough collected 105 operations; 42 per cent. were improved; 58 per cent. were not improved; 29.5 per cent. died within thirty days. Two years after operation 9 cases were apparently in good health ("Am. Jour. Med. Sciences, Dec., 1902).

Operation for Intussusception.—Air distention and hydrostatic pressure are uncertain; in an advanced case may rupture the gut; even in a recent case may fail or may reduce the bulk of the intussusception, but not its apex. Russell ("Intercol. Med. Jour. of Australasia," March 20, 1902) alludes to the uncertainty of the method. He used hydrostatic pressure in 5 cases. Two died and two recovered. In one case the method failed and operation was then performed. It is safer and better to operate early, but if the conservative plan is tried and fails, operation should certainly be done at once, because an early operation enables the surgeon easily to effect reduction, and also because early complications are unusual. The incision is made in the mid-line above the umbilicus. The surgeon endeavors by manipulation to reduce the intussusception by pushing it back, not by pulling it out. If the intussusception is gangrenous, perform intestinal resection and circular enterorrhaphy. The same rule maintains when malignant disease of the gut exists (D'Arcy Power). It is inadvisable to make an artificial anus. Maunsell's operation is suited to cases of irreducible intussusception. It is performed as follows: A longitudinal incision is made

in the intussuscipiens. The intussusception is gently pulled upon and is caused to protrude from this opening. Two straight needles threaded with horse-hair are passed so as to transfix the base, and one-fourth of an inch above the needles the intussusception is cut off. The needles are carried completely through, the sutures are hooked up in the middle and cut, and the two ends are tied on each side. These sutures unite the intussusception to the intussuscipiens. The two surfaces are now carefully approximated by sutures. The sutures are cut. The stump is replaced. The longitudinal incision is closed with Lembert sutures.\*

Russell reports 16 cases operated upon: 12 recovered and 4 died. In every one of the 4 fatal cases the diagnosis was not made until the disease had lasted several days. In 2 of the successful cases the diagnosis was made late ("Intercolonial Med. Jour. of Australasia," March 20, 1902). If operation is done in the first twelve hours the mortality, even in infants, will scarcely exceed 15 per cent. If gangrene exists the mortality is enormous (at least 90 per cent.).

Senn's Operation for Fecal Fistula.—Suture the opening transversely with Czerny sutures of silk in order to prevent infection. Cleanse the surface thoroughly. Open the abdomen and separate the edges of the bowel from the parietés. Deliver the portion of bowel which contains the fistula and apply Lembert sutures over the Czerny sutures. Another method is to open the abdomen above the fistula, insert the fingers, cut out the skin and tissues around the fistula in an elliptical course, leaving them attached to the bowel, draw the bowel from the abdomen, pack gauze around, remove the tissues adherent to it, and suture the fistula transversely (Hearn).

Enterostomy is the making of an artificial anus. If performed in the large bowel, it is called colostomy. In some cases of intestinal obstruction it is necessary to open the small intestine, and if this is required, the artificial anus should be made as near as possible to the cecum. The nearer to the stomach it is made, the more apt is the patient to die of lack of nourishment. The anus may be made in the middle line or in the right iliac region. The bowel is fixed and opened as directed under colostomy. In acute intestinal obstruction it may be necessary to open the bowel at once. In such a case Paul's tube is very useful. Paul's tube is made of glass, is bent to a right angle, and has a rim near each end. The large tube is used in the colon, the small tube in the small intestine. A small opening is made in the intestine, the tube is introduced, and is tied in place by a silk suture which surrounds. all the coats of the bowel, a gush of feces is caught in a basin, a rubber tube is fastened to the glass tube, and fluid feces are collected in a bottle and beneath an antiseptic fluid.† In from three or four days to a week the tube becomes loose and can be removed. Stewart's method of enterostomy was outlined on page 977-

Inguinal Colostomy.—Maydl's Operation (Fig. 629).—In this operation a vertical or oblique incision four inches long is made over the portion of colon to be incised. In all cases where it is possible, do a left inguinal colostomy. In right inguinal colostomy it is difficult to deliver the bowel as in a left inguinal colostomy, because of shortness or absence of mesocolon at this point of the

<sup>\*</sup>T. Pickering Pick, Quarterly Med. Jour., Jan., 1897. † Paul, in Liverpool Med.-Chir. Jour., July, 1892.

colon. Right inguinal colostomy has been performed for chronic amebic dysentery. It puts the colon at rest and permits of free irrigation. It is kept pen until the dysentery is well. Appendicostomy has replaced it for dysentery.



Fig. 627.—Stevenson's bag for inguinal colostomy.

has also been employed for the treatment of ulceration of the colon. After the incision on the left side the colon usually bulges into the wound, but if it does not, it may easily be found by following with the finger the parietal peritoneum outward, backward, and inward, the first obstruction it encounters



Fig. 628.—Stevenson's bag applied.

being the mesocolon. Draw the colon out of the wound until its mesenteric attachment is level with the abdominal incision. Push a glass bar through a slit in the mesocolon near the bowel, and wrap the ends of the bar with iodo-

form gauze to prevent slipping. Instead of the bar, a pemployed, or a bridge of skin can be made under the betwo skin edges. The two parts of the flexure are stitched which penetrate to and catch the submucous coat (Fig. 62 coat of the bowel to the parietal peritoneum. Wheneve twenty-four to forty-eight hours before opening the gut. by the cautery or by scissors. If the artificial anus is to a transverse incision through the bowel. Cut one-four colon when it is first opened, and entirely across at a late ficial anus is to be temporary, the incision should be looperation has great advantages: it is quick, certain, reastorily prevents fecal accumulation below the opening, and absolute fecal incontinence. In many cases the bowels respectively.



Fig. 629.-Inguinal colostomy (after Zuckerkandl).

times a day however, com tle warning. no warning. there will be long as it las ered with gau by a firm bel permanent a

Bodine's 630).—Bodin tomy permits tion of the fec performed an geon maintai

colostomy should reach to and remain at the lev condition impossible of attainment by hanging the or piece of gauze, because a spur thus formed rigid and is inevitably dragged below the skin-level, a ging has taken place, some fecal matter will pass into artificial anus. Bodine opens the abdomen, sutures the to the skin, seeks for the lesion, and draws it with six inc out of the incision. He lays the limbs of the loop side a silk stitch, beginning at the point where exsection is to inches unites the two segments close to their mesenteric is dropped into the abdomen until the beginning of the with the skin, and at this point it is fastened to the abde continuous catgut suture. The protruding lesion is cut line (Fig. 630). The artificial anus is thus established. to close the artificial anus, divide the septum with scisso (Fig. 631) and close the abdominal wound.\*

Lumbar Colostomy.—Lumbar colostomy is a most ation. It does not completely intercept the fecal curre patient in a condition of wretched discomfort because inevitable. A patient who has had lumbar colostomy

\*New York Polyclinic, Feb. 15, 1897.

ither obtains little benefit because the feces pass into the bowel below the pening which was made to intercept them or else they pour out of the openng uncontrolled, making the poor unfortunate a living horror to himself and others. It is rarely performed at the present day.

The Healthy Gall-bladder .- A healthy gall-bladder has a capacity of about 1 ounce, and its hue is bluish. If a gall-bladder contains calculi or

has contained them, its hue is grayish-white or yellowish (Moynihan).

Congenital Absence of the Gall-bladder.—When the gall-bladder is shrunken and buried in adhesions, it is very hard to find at operation. Sometimes it is not found and one may jump to the conclusion that it is congenitally absent. This is occasionally, but very seldom the case. Gray collected 19 instances of congenital absence of the gall-bladder ("Trans. of Chicago

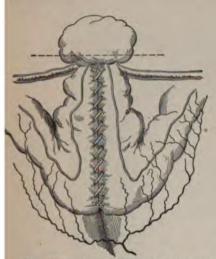


Fig. 630 .- Bodine's method of colostomy, howing one side of the loop after it has been suured, passed back into the cavity, and stitched nto the abdominal wound. The lesion is left proruding, and the dotted line indicates where the protrusion is to be clipped off.

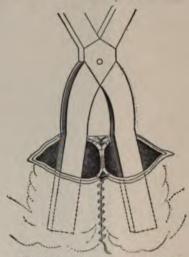


Fig. 631.-Bodine's method of colostomy, showing the septum to be divided in restoring the fecal current; Grant's clamp in position for the division. (In permanent colostomy this septum remains as a rigid and effective spur.)

Path. Soc.," 1902). When it is absent the subject seems to get along perfectly well without it.

The Incision for Operations upon the Gall-bladder and Bileducts.—I have employed several methods, but for some years have been most content with Bevan's incision (Fig. 632). The primary portion of the incision is shaped like the italic letter f. It is by the side of or through the right rectus muscle, and is shown by the double line in Fig. 632. The primary incision is used for exploration and cholecystotomy. The primary incision is from three to four inches long, and the extended portions, shown by heavy lines n Fig. 632, are added if required (Arthur Dean Bevan, "Annals of Surgery," July, 1899). This incision gives most satisfactory exposure, its edges can be separated without tension, and it injures but few of the nerves of the abdominal walls.

I believe it to be superior to Kocher's incision (Fig. 632), which cuts the

and the peritoneum to be incised in the same direction as the skin and anterior wall. The upper end of this diagonal incision through the posterior all extends into the short, transverse incision across the linea alba. When is last cut is made the incision pulls open and gives ready access to the right upper abdomen." This incision does not damage the intercostal nerves, hence muscular atrophy is avoided. The opening through the different planes of the abdominal wall are not continuous, hence closure will be more solid. The opening in the posterior portion of the rectus sheath is protected uninjured muscle.

Cholecystostomy or, as many call it, cholecystotomy is the oper-

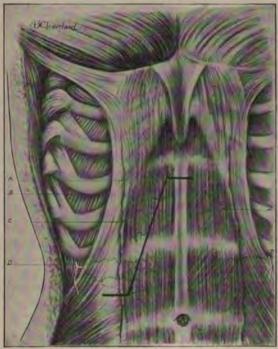


Fig. 633.—A, anterior wall of sheath of rectus muscle; B, posterior wall of sheath; C, tus muscle; D, intercostal nerves. The direction of the incision through the skin, fat, and the rior wall of the sheath of the rectus muscle (Collins).

the Mayos, operations for stone exhibit a mortality of less than 1 per cent.; cher's mortality is 2 per cent. When death follows an operation on the gall-dder or ducts, in about one-half the cases it is due to duct infection and is cases of acute cholecystitis, in hydrops, and in empyema of the gall-bladder; gall-stone cases in which jaundice has lasted for four weeks or more, and in colic of the gall-bladder with fever, the colic having recurred a second or third time (Carl Beck). The operation completed in one stage is performed as follows: The patient is placed recumbent with a sand-pillow under the back and

the incision is made. The peritoneum is opened. If the gall-bladder is distended, it is surrounded with pads and aspirated, and is then opened. Gall I small stones are removed by forceps, the scoop, or irrigation. The gall-ducts are examined by the fingers external to them, and are sounded, if possible. If a stone is wedged in the duct, try to manipulate it back into the gall-bladder If this fails, introduce an instrument from the gall-bladder and break up the stone; if this fails, open the duct, remove the stone, and close the incision in the duct (A. W. Mayo Robson). The only way to be certain that stones have been entirely removed from the cystic duct is to insert a finger and dilates the Sounds are unreliable. After the removal of all stones and fragments pass rubber tube which has no side perforations into the gall-bladder, cut it o off level with the cutaneous surface, purse up the cut in the gall-bladder around and the tube by means of a catgut suture, and suture the gall-bladder to the abdom nal aponeurosis. If sutured to the skin, a permanent biliary fistula is apt follow. It will seldom follow if the gall-bladder is sutured to the aponeuros-is. The gauze is now removed and the drainage-tube can usually be dispensed with in from one week to ten days. It should not be dispensed with ar a til the bile becomes sterile.

Some surgeons have advocated immediate suture of the gall-bladder after removing a stone (ideal cholecystotomy). I believe this is never advisable when the stones are active for harm, because small calculi may be in the durant and minute fragments of stone are often left in the bladder, and the draining will remove them and relieve the diseased condition of the gall-ducts bladder. In Kocher's 31 operations by this method, gall-stones reformed in 3 cases. Further, the operation with immediate suture is decidedly and dangerous when infection exists. The Mayos only employ it in latent of gall-stone disease when the existence of stones is discovered during performance of an abdominal operation.

It is advised by some that the operation of cholecystostomy be performed in two stages. First, the bladder is exposed and sutured to the parietal process. When adhesion takes place, the gall-bladder can be opened with risk of infecting the general peritoneal surface. Riedel advocates operation two stages, and so did Christian Fenger in certain cases. The two-st operation is objectionable because it does not permit of satisfactory explication of the ducts. The biliary fistula which is left by cholecystostomy usus closes spontaneously, but may not. If it does not close and the secretion pure mucus, it is evident that the cystic duct is absolutely blocked a cholecystectomy should be performed.

If the secretion from a persistent fistula is bile and if the common duct is obstructed, separate the edges of the gall-bladder opening from the pariet peritoneum, endeavoring to avoid entering the abdominal cavity, and clothe fistula with Lembert or Halsted sutures. If the secretion is bile and the common duct is obstructed permanently, perform cholecystenterostom In 214 cases of cholecystotomy for stone in the gall-bladder, in the cystiduct, or both, the Mayos had 2 deaths (Wm. J. Mayo, "Annals of Surgery, June, 1902). At the end of 1907 Hans Kehr placed his mortality at 2 percent. ("Jour. de Chir.," Oct., 1908).

Cholecystenterostomy consists in making an anastomosis between the gall-bladder and intestine, preferably the duodenum, or, if this cannot be done, to the jejunum. It is employed in cases of irremovable obstruction of the cystic or common duct. It is done chiefly in cases of malignant obstruction. It is not a suitable operation for gall-stones impacted in the common duct, because it does not remove the cause of trouble, infection of the bile-passages may follow, and the fistula is liable to contract. In those rare cases of common duct obstruction from gall-stones in which the gall-bladder is distended and the patient is desperately ill, it may be done (Robson). In such a case Robson attaches the gall-bladder to the colon because the operation is easier and because he considers it as useful as the attachment to the duodenum. Cholecystenterostomy can be done most rapidly and successfully by means of a small Murphy button. Before the gall-bladder is incised it is aspirated. Murphy's operation is shown in Fig. 634, and is similar in per-

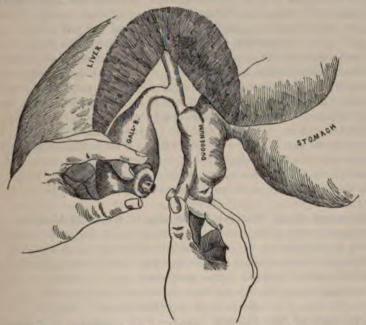


Fig. 634.—Showing method of holding parts while approximating a Murphy button in cholecystenterostomy.

formance to intestinal anastomosis. I believe that Brentano is right and that it is best to do posterior cholecystenterostomy, bringing the jejunum through an opening made in the transverse mesocolon.

Cholecystectomy is the extirpation of the gall-bladder. It was first performed by Langenbuch in 1682. Sometimes primary extirpation is performed; at other times cholecystectomy is performed as a secondary operation, cholecystostomy for drainage having been first performed. Its performance may be demanded by the existence of phlegmonous inflammation or gangrene, ulceration, "in chronic cholecystitis from gall-stones where the gall-bladder is shrunken and too small to safely drain, and where the common duct is free from obstruction" (A. W. Mayo Robson), in empyema with greatly damaged walls, in fistula associated with irremediable obstruction of the cystic

duct, the common duct being free, in cancer, and in some wounds of the gall-bladder. Objections to the operation are that drainage can only be obtained by putting a tube into the hepatic or the common duct and that, should renewed drainage be subsequently required, the necessary operation will prove difficult and dangerous (Maurice H. Richardson, "Medical News," May 2, 1903).

After opening the abdomen the gall-bladder is found and is drawn into the wound. If it is distended and tense or if it is thought "to contain infectious fluid" (Lilienthal), it is packed about with iodoform gauze and emptied by an aspirating trocar. "When the walls are very friable, it is even wise to incise and empty the viscus, closing the opening by ligature or clamp before proceeding with the extirpation. The gall-bladder is usually quite a tough organ, and in the majority of cases it may be grasped with an ovarian ring-clamp applied near its fundus, which at the same time closes the aspiration puncture" (Lilienthal, "Annals of Surgery," July, 1904). The peritoneum which covers the gall-bladder must be divided just below the liver, the gall-bladder is dissected from the liver until the cystic duct is reached, the cystic artery is tied and divided, and if the liver ducts are healthy, the cystic duct is ligated with silk and divided, the stump is touched with pure carbolic acid and is covered with a layer of peritoneum fastened by sutures of fine silk. In cases free from infection it is not necessary to drain the bileducts. In cases with cholangitis external drainage is necessary and it is obtained by incising the hepatic duct and inserting a drainage-tube, or, better, by leaving the stump of the cystic duct open. Wm. J. Mayo reports 33 cases of cholecystectomy with 1 death ("Annals of Sargery," June, 1902). Howard Lilienthal reports 42 cases with 1 death ("Annals of Surgery," July, 1904). Hans Kehr's mortality at the end of 1907 was 3.6 per cent. ("Jour. de Chir.," Oct., 1908).

Removal of the Mucous Membrane of the Gall-bladder.—Mayo has suggested the removal of the fundus and of all the mucous membrane of the gall-bladder as an occasional substitute for cholecystectomy. By this operation we are enabled to drain the cystic duct and through it the hepaticutes. A serious objection to the operation is that, as glands pass from the mucous coat to and through the muscular coat, it is impossible absolutely be remove the mucous membrane of the gall-bladder alone (Emil Ries).

Drainage of the Hepatic Duct.—This operation is employed certain hepatic infections. It was first performed by Cabot in 1892. If the cystic duct is dilated throughout, it may be carried out through that. After opening the gall-bladder a tube is passed through the cystic and into the hepatic duct. It is often done after opening the common duct, a tube being carried up into the hepatic duct. The hepatic duct may be exposed an opened directly, a tube being carried into it for a short distance and stitches to the edges of the incision in the duct by catgut. The tube should be surrounded by iodoform gauze.

Choledochotomy is the operation of incising the common duct for the removal of a stone. It is also called choledocholithotomy. It was first performed by Courvoisier in 1890.

Cases upon which this operation is done are often deeply jaundiced and there is grave danger of infection and of fatal oozing of blood. In one of my cases this happened. The patient was laboring under stones in the common duct, associated with cancer of the head of the pancreas. In every case in which operation is contemplated for obstruction of the bile-ducts, take the coagulation time of the blood. Normal coagulation time (taken by Wright's coagulometer) is from three to six minutes. Prolongation to seven or eight minutes calls for pre-operative treatment to hasten coagulability. If jaundice exists, it is customary to endeavor to prevent hemorrhage by employing Robson's plan: Give by the mouth from 30 to 60 grains of chlorid of calcium hree times a day during the twenty-four or forty-eight hours preceding the peration, and 60 grains by enema three times a day for the forty-eight hours collowing the operation. I have followed this course in a number of cases, but m not convinced of its value. Instead of this method we may follow the lan of giving thyroid extract (gr. v three times a day) for several days preceding the operation.

The plan I now pursue I am certain does reduce the coagulation time disnctly. I give an injection of diphtheria antitoxin (horse serum) the day

lore operation and another the morning of the operation.

When ready to operate, a sand-bag should be placed under the lower ribs.

This will bring the liver at least two inches nearer to the abdominal wound.

The abdominal incision must be longer than that employed for cholecysstomy. The pylorus and stomach are drawn to the left, the colon and omentum are drawn downward, and the liver and ribs are lifted strongly upward.

The pylorus and the liver and ribs are lifted strongly upward.

The pylorus and the liver and ribs are lifted strongly upward.

"The operator should now, after having separated adhesions, have a good view of the common duct within the free border of the lesser omentum, and on inserting his left index-finger into the foramen of Winslow, or on google sping the duct between the index-finger and thumb, he can, without difficulty, bring the duct well within reach, the concretion making a distinct projection."\* A longitudinal incision is made, the stone is removed, and a probe is introduced into the duct to determine whether other stones are present.

Stones in the second and third portions of the duct are often missed and the second portion of the duodenum should always be palpated with the utmost care. If the lowermost stone removed from the common duct is faceted we should always search most carefully to find a concretion which is lower still

(F. Gregory Connell, "Annals of Surg.," April, 1908).

If a calculus is found in the lower part of the common duct the surgeon es to push it up so that he may reach it. This can usually be accomplished. The fails to push the stone up into reach, he must try and force it into the duodenum. This attempt will sometimes, but seldom, succeeded. If it does succeed he must perform a transduodenal or a retroduodenal operation. If it proper to cholecystostomy or cholecystenterostomy. If either of these palliative perations is performed a radical operation must be done later.

Many surgeons suture the incision in the duct. This procedure is rendered easier by the use of Halsted's hammer, which draws the duct toward

the surface and keeps it under control (Fig. 635).

Interrupted sutures of fine catgut are used. The muscular and serous coats may be included in each suture, and over this layer Lembert or Halsted sutures are applied. A drainage-tube is inserted and a piece of iodoform

<sup>\*</sup> A. W. Mayo Robson's "Treatise on Diseases of the Gall-bladder and Bile-ducts."

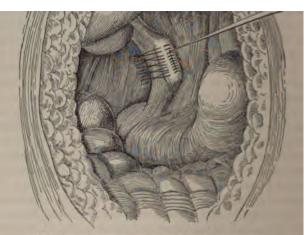


Fig. 635.-Suture of duct over Halsted's hammer.

or inserts a rubber drainage-tube into the opening and carries it the hepatic duct, or makes an incision into the right loin after Rutherford Morison, and carries a tube into the right kidney pour the most dependent part of the peritoneal cavity when the patient is Personally I always drain the duct, when I have opened it for storthe tube up to the hepatic duct. The same reasons which cause us gall-bladder after removing stones should influence us in this case.

Robson ("Lancet," April 12, 1902) has performed the operatidochotomy 60 times. In 10 cases of stone in the common duct lated the stone back into the gall-bladder and removed it through in that viscus by means of a scoop. The above maneuver is imported the cystic duct is dilated. In 30 cases he crushed the stones between and thumb, but this is only possible when the the stones are soft, at objection that it may leave fragments. If a stone is lodged in the duct and cannot be manipulated back into the gall-bladder, chol

stone in the hepatic duct. The operation was first performed by Kocher in 1889. There were 7 cases on record in 1903 (Delagenière, in "Bull. et Mém. de Chir. de Paris," No. 10, 1903).

Duodenocholedochotomy (McBurney's Operation; the Transduodenal Roule).—This operation is seldom necessary. In the more than 2000 operations performed by the Mayos on the gall-bladder and ducts, this operation was only required in 4 cases. I have never performed it. In 1891 McBurney proposed this method for the removal of gall-stones impacted near the papilla ("Annals of Surgery," Oct., 1898). McBurney's original suggestion was to open the duodenum, dilate or incise the papilla, remove the stone, and suture the duodenum. If the stone is located in the diverticulum of Vater it may, in some few cases, be removed by simply stretching the opening of the duct with forceps (Collins's method). If this is not possible, the opening in the papilla may be enlarged by cutting or the duodenal mucous membrane over the stone may be incised (McBurney's plan). When the stone is not impacted at the outlet, but is lodged a little higher up, and when dense adhesions render access by the ordinary supraduodenal route difficult or impossible, the anterior wall of the duodenum may be opened longitudinally, the posterior wall of the duodenum and the common duct incised over the stone, the stone removed, the duodenum and common duct sutured together (Kocher's method, or internal choledochoduodenostomy), and the anterior wall of the duodenum closed. (See Charles Otto Thienhaus, in "Annals of Surgery," Dec., 1902.) After finding and removing a stone by the transduodenal route we must make a careful search to see no stones are left before closing the duodenal incision. Robson opposes the transduodenal route and says he has abandoned it because of the danger of sepsis. Thienhaus ("Annals of Surgery," Dec., 1902) opposes this view of Robson and shows that in 29 operations by the transduodenal route there were but 2 deaths.

Connell ("Annals of Surgery," Jan., 1908) has collected 77 cases in which stones were removed by the transduodenal route. There were 10 deaths. In of these cases duodenal fistula preceded death.

Retroduodenal Choledochotomy.—In this operation the second portion of the common duct is incised back of the duodenum without opening the gut. That this may be done the duodenum must first be drawn toward the midline of the body, and this can be done only by "mobilizing" the duodenum, incising the posterior layer of the parietal peritoneum one inch to the right of the descending portion of the duodenum. After freeing the gut and retroperitoneal structures the duodenum becomes sufficiently free to lift toward the left with a tation. We thus expose the posterior aspect of the duodenum, the head of the pancreas, and the common duct.

The duct is opened, the stone removed, the duct sutured, and a drain in-

This operation has been successfully performed by a number of surgeons, but there is a great objection to it. In nearly all cases the common bile-duct Passes through the pancreas rather than back of it. Büngner found this to be the case in 55 out of 58 dissections ("Gray's Anatomy," Seventeenth American edition, p. 1352). Hence, incision of the common duct in this situation means in nearly all cases incision of the pancreas and all the grave dangers of leaking of pancreatic fluid. The transduodenal operation is a much better procedure.

Total Splenectomy.—This operation is performed for wounds and rupture of the spleen, tumors, cysts, floating spleen, and non-leukemic splenic hypertrophy. Twisting of the pedicle of an ectopic or wandering spleen calls imperatively for operation. It should not be performed for hypertrophy in leukemia.

In view of the bone-marrow changes in splenomyelogenous leukemia, we cannot hope to cure a patient by removing the spleen. In a leukemic patient the operation has a very high mortality from shock and hemorrhage. Geo. Ben Johnston ("Annals of Surgery," Jan., 1908) has collected 49 splenectomies in leukemia with only 6 operative recoveries (a mortality of 87.7 per cent.). One of the 6 cases lived eight months, 1 lived four years, and it is claimed that 1 was cured.

Splenectomy has been performed for malarial hypertrophy (ague cake), The operation has been advocated on the theory that by removing the spleen we would get rid of the lurking place of the malarial parasites, but they also lurk in the bone-marrow and in the capillaries of the liver. The operation should not be performed for malarial spleen unless the organ is movable, unless it greatly interferes with the patient's comfort or occupation, or unless we fear rupture, and then, if it is done, it is for the movability, the discomfort, or the danger, and not for the malaria. It is to be noted that the operation does not cure the malaria. Johnston (Ibid.) collected 58 splenectomies performed for malarial hypertrophy since 1900. There were 50 recoveries and 8 deaths. To these he adds 3 successful ones of his own, making 61 cases, with 8 deaths (a mortality of 13.1 per cent.).

A number of operations have been done for splenic anemia or its terminal stage, which is known as Banti's disease. It is improbable that splenic disease is the cause of the anemia, but it is much more probable that some underlying condition causes splenic enlargement and anemia. The operation does not seem to be founded on sound pathologic indications, although it is proper to state that Cushing's case was alive and well eight years after the operation.

Johnston (Ibid.) has collected 61 splenectomies for splenic anemia or Banti's disease. There were 49 recoveries and 12 deaths, a mortality of 19.5 per cent.

Johnston (Ibid.) notes 12 splenectomies for sarcoma of the spleen with 9 recoveries. One lived eight and one-half years and died of heart disease. Three are known to have died from recurrent sarcoma.

It is stated that there are on record 4 splenectomies for cancer. Moynihan doubts the diagnostic accuracy of the three earlier reports. Mary A. Smith records a case of colloid cancer occurring in a woman who had been operated on ten years before for ovarian cyst associated with pseudomyxoma of the peritoneum. The pathologist reported that the growth in the spleen was a metastasis of colloid carcinoma. This patient died seven months after the splenectomy from peritoneal and omental cancer ("Annals of Surgery," Jan., 1908).

In Johnston's (Ibid.) table of 708 splenectomies for various causes the mortality is 27.4 per cent. In the cases operated upon from 1900 to 1907 inclusive the mortality is 18.5 per cent.

In order to remove the spleen make an incision from the anterosuperior spine of the ilium to the ribs, open the peritoneum, and divide adhesions between ligatures. If the spleen is adherent to the pancreas, it may be necessary to remove a fragment of the last-named organ. It is a very undesirable thing to have to do, and I lost a case from pancreatic leakage after having done it. Ligate the suspensory ligament and divide it. Bring the spleen well out of the wound. Surround it with gauze pads. Transfix the pedicle with stout silk. Tie it firmly, leaving the ends of the ligature long for a time, and cut through the pedicle beyond the ligature. Ligate the vessels separately with catgut. Cut off the long ends of the silk ligature and drop the pedicle back, unless apprehensive of bleeding, when it may be fastened to the surface. The wound is closed without drainage. Traction upon and ligation of the vessels in the pedicle may cause profound shock by injuring the splenic plexus, which is in close relation with the solar plexus (Jordan, in "Lancet," Jan. 22, 1800).

Changes After Splenectomy.—About two weeks after the removal of a normal spleen certain definite changes happen in adults, but not in children. These changes last for several weeks and are manifested by enlargement of the lymph-glands, tenderness of bones, blood-changes, loss of weight, weakness, thirst, polyuria, abdominal pain, elevation of temperature, and rapid pulse.\* Tizzoni says that these changes are not obvious in children, because in them compensatory organs act at once, whereas in adults compensatory organs act slowly and with painful effort. Such symptoms are noticed when the spleen is removed because of a wound or a rupture, but rarely after removal of a diseased spleen. It is likely that compensating organs become active when the spleen is diseased, and consequently are in full operation when such a spleen is removed. After partial splenectomy these changes are not noted (Jordan). Changes can be prevented after splenectomy by the administration of tablets of extract of spleen and red bone-marrow (Ballance).

The blood changes after splenectomy consist of diminution in hemoglobin and red blood-cells. The coloring matter and cells do not become normal for two or three months.

Splenopexy.—This is the operation of anchoring a movable spleen. It can only be used when the spleen is not enlarged and is not diseased. Rydygier in 1895 published the first case, although both Tuffier and Kouwer operated before this date. Sutures should not be passed through the spleen: the structure is so soft the stitches are bound to loosen and the insertion will cause bleeding. A promising method is to create adhesions by the use of iodoform gauze, as is done for movable kidney, and as was done by Kouwer. Some advocate making a pocket outside of the peritoneum and bringing the spleen into this pocket, thus placing it extraperitoneal.

Abdominal Hernia or Rupture.—A hernia is a protrusion of peritoneum liable to contain, containing at times, or permanently containing any viscus or part of a viscus from the abdominal cavity. MacCormac says the term implies that the protruded viscus is covered with integument; hence a protrusion of viscera through a wound does not constitute a hernia. A hernia has three parts—the sac, the sac-contents, and the sac-coverings (Fig. 636). The sac is formed of peritoneum. A congenital sac is due to developmental defect, and may be in the inguinal region, the umbilical region, the lumbar region, or in the epigastric region as a result of a congenital slit in the transversalis

<sup>\*</sup>Ballance, in Practitioner, April, 1808; H. Martyn Jordan, in Lancet, Jan. 22, 1898.

fascia. It used to be stated that femoral hernia was never congenital, but Russell and Coley both say that a femoral hernia may have a congenital sac. In 100 necropsies Murray found 20 potential femoral sacs (sacs into which a hernia had not entered). An acquired sac is due to intra-abdominal pressure bulging the peritoneal covering of an abdominal ring and converting it into a pouch. The sac comprises a body, a neck, and a mouth. A sac once formed is almost certain to persist, because it adheres by its outer surface to surrounding parts, and hence the sac of a hernia is usually irreducible even when the contents are reducible. The neck of the sac is due to the constriction through which the sac passes; it becomes furrowed and folded,

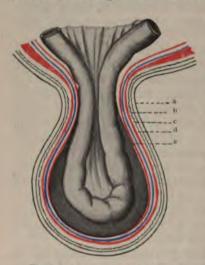


Fig. 636.—A diagrammatic representation of the coverings of a hernia (Sultan): a, The skin; b, the superficial fascia; c, the muscular layer—e. g., the cremaster muscle in an inguinal hernia; d, the transversali fascia; c, d, have also been called the fascia propria herniæ; e, the peritoneum—i. e., the sac of the hernia.

and the adhesion of these folds causes thickening and rigidity. Hernia of the bladder or of the cecum may have no sac or but a partial sac. A ventral hernia following an abdominal operation may be without a sac. The contents of the sac depend chiefly on the situation, a portion of the ileum being the usual contents. The colon, the stomach, the great omentum, the bladder, and other structures may enter the hernial sac. An enterocele contains only intestine; an epiplocele contains only omentum; an entero-epiplocele contains both omentum and intestine; a cystocele contains a portion of the bladder. The coverings of the sac, which vary with its situation, will be set forth during the consideration of special forms of hernia. In old hernia the layers are never distinct, fat and muscle waste, tissues adhere, and the skin stretches and atrophies. The sac of an old hernia occasionally becomes tuberculous, and the disease may remain local in

the hernia sac or spread to the general peritoneum. Renault tells us that tuberculosis of a hernia is made manifest by increase in size, pain on pressure,

and loss of body-weight.

Causes of Hernia.—Hernia is a common trouble. According to Berger, in 1000 people 4.4 per cent. suffer form hernia. It occurs at all periods of life, and hereditary predisposition sometimes seems to exist. The male sex is three times as liable to hernia as the female sex. That increase of intraabdominal tension is a common cause in children has been amply demonstrated. (See Hernia in Childhood, page 1152.) Excessive length of the mesentery has been assigned as a cause. In some instances a mass of fat forms (fat hernia) and advances before the hernia, and seems to bear a causative relation to it. Lucas-Championnière explains this as follows: when a person begins to take on fat, it is deposited not only under the skin, but also in the omentum, mesentery, and subperitoneal tissues. This semifluid fat is easily

Influenced by pressure. The deposit of fat within the abdomen lessens the size of that cavity, intra-abdominal pressure is increased, and fat protrudes at any weak spot in the wall. The protruding mass of fat adheres to and makes traction upon the peritoneum, and this membrane is drawn upon to form a sac, and the sac is surrounded by fat. This method of formation is frequently noticed in umbilical herniæ, and occasionally in inguinal herniæ. Any laborious occupation predisposes to rupture. Any condition which weakens the abdominal wall predisposes to rupture (muscular relaxation from ill-health, relaxation of abdominal walls following the termination of pregnancy, the removal of a large tumor, or tapping for ascites, and wounds or abscesses of the abdominal wall). The common cause is repeated muscular effort which increases intra-abdominal tension (straining at stool, coughing, lifting weights, jumping, the sexual act, and straining during micturition). In 25 per cent, of cases the cause is supposed to have been lifting or carrying a weight (Coley). A hernia may appear gradually or suddenly. Berger and Coley state that nearly 70 per cent. of hernia in adult males appear gradually. The sac of an acquired hernia exists for a longer or shorter time before the hernia enters it. The sac of a congenital hernia is present at birth. The sac of an acquired hernia gradually forms. A sac may exist for years and yet remain empty. When bowel or omentum enters it from some strain or effort, the parts were long prepared to receive the extruded mass. This extrusion may occur gradually or it may occur suddenly. If it occurs suddenly, the sufferer believes that his hernia was formed then and there, but, as a matter of fact, the extrusion of bowel or omentum and its entrance into the sac are but the last of a long series of antecedent and preparatory changes. Finally, a hernia appears, and usually does so during effort. In rare cases traumatism may cause a hernia immediately, no sac existing before the accident. It does so in the inguinal region by stretching or tearing the internal ring, the inguinal canal at once enlarging. Such a condition is a true traumatic hernia, traumatism being the sole cause and not simply the exciting cause.

The old and erroneous idea was that a hernia was always formed by tearing of the peritoneum; hence the term rupture. This mode of formation is extremely unusual, but occasionally does occur. Coley saw such a case. An ordinary non-traumatic hernia, when the bowel suddenly and for the first time enters the sac, is the seat of some pain, but the pain is not disabling and the lump disappears on recumbency. In many cases the bowel or omentum gradually finds a way into the sac, and in such cases pain is usually trivial and often absent. In true traumatic hernia there are violent pain, collapse, vomiting, inability to walk and stand, and the mass does not return to the belly on recumbency, but must be reduced by taxis or operation. True traumatic herniæ may occur anywhere in the abdomen, but are most common in the inguinal region, where they are direct herniæ. (The relation born by accidents to the development of hernia is discussed by Paul Berger, in "Rev. de Chir.," April and May, 1906, and by Wm. B. Coley, in "Internat. Jour. of Surg.," Feb., 1908). All congenital herniæ are due to structural defects. Herniæ are divided clinically into reducible, irreducible, incarcerated, inflamed, and

strangulated.

Reducible Hernia.—In this form of hernia the contents of the sac can be reduced into the abdominal cavity. At a known hernial opening the patient has a smooth enlargement (narrower above than below), which began to grow above and extended downward. A distinct neck can often be felt. In enterocele, straining, lifting, or standing enlarges the mass; the protrusion becomes smaller and may disappear on lying down; cough causes impulse or succussion, the protrusion is elastic, and may be tympanitic on percussion, and on reduction the mass suddenly disappears and there is a gurgling sound. In epiplocele the mass is often irregular and compressible, and feels boggy rather than elastic; muscular effort does not have much influence in enlarging it; impulse on coughing is slight; percussion gives a dull note, and reduction is accomplished gradually and produces no gurgling sound. In entero-epiplocele some parts of the mass are smooth, elastic, and tympanitic; others are dull on percussion, irregular, and flabby, but the diagnosis of this especial form is uncertain. The victims of reducible hernia complain of some pain on exertion, of dyspepsia, and often of constipation.

When a hernia is beginning to form, there is often premonitory uneasiness. The patient complains of muscular pain in the lower abdomen, and this condition may exist for weeks before it is recognized that a hernia is present. An inguinal hernia can be recognized before it protrudes from the external ring. The tip of the finger is inserted in the ring and the patient is asked to cough. If a hernia has entered the canal, succussion will be detected on coughing. In a healthy man the external ring should admit the tip of the little finger, but not the end of the index-finger. If the end of the index-finger can be made to enter the ring, that aperture is dilated, and even if there is no hernia in the canal, in future a hernia will probably descend. In a man, if the surgeon desires to examine the ring, he inverts the skin of the scrotum over the finger and carries the finger to or in the ring. When the hernia first appears, there may be pain, faintness, and some sick stomach; but often there is no pain or any discomfort.

Treatment of Reducible Hernia,-Palliative Treatment.-Prevent constipation, forbid sudden strains and violent exercise, and order a truss. The continued employment of a truss in young persons may bring about a cure. The day truss should be applied before rising in the morning and be removed after lying down at night, when a light truss should be substituted. A special truss is applied before bathing. In very fat people there is always trouble in adjusting a truss. A femoral hernia is more difficult to keep reduced than an inguinal hernia. In a hernia in which the gut is replaceable, but a portion of omentum is irreducible, it is difficult to maintain reduction of the gut with a truss, and an operation should be performed. In an oblique inguinal hernia the pad of the truss fits over the internal abdominal ring; in a direct inguinal hernia, over the external abdominal ring; in a femoral hernia, over the femoral ring at the level of Gimbernat's ligament. Mac-Cormac's method of measuring for a truss is as follows: in either inguinal or femoral hernia start the tape from the lower part of the hernial opening, carry it up to the anterior-superior iliac spine of the same side, then take it around the body, one inch below the crest of the ilium, to the other anterior-superior iliac spine, and then to the upper part of the hernial opening." A well-fitting truss will keep the hernia up even when the patient sits in a position to relax the abdominal walls and coughs and strains. A truss is

<sup>\*</sup>Treves's "Manual of Surgery," "Hernia."

always uncomfortable at first, but a person usually becomes accustomed to it. It should be kept scrupulously clean, and borated talc powder should be dusted upon the skin under the pad at least once a day. A truss which does not keep the hernia up or which causes pain does harm. Too strong a spring tends to enlarge the hernial orifice, and thus aggravates the case. Even after an apparent cure with a truss the instrument must be worn for a long time.

Radical treatment of reducible and of non-strangulated hernia seeks to obtain cure by plugging the mouth of the sac or by obliterating the canal of descent. Radical operations should be performed when a strangulated hernia is operated upon, in ordinary cases of reducible hernia in which a truss is very painful or does not keep the bowel up, in most cases of irreducible hernia, and in any case of hernia in which there are occasional attacks of obstruction. It was formerly believed that a cure would fail if the subject was under three years of age, but Coley and others have proved that it is a very successful operation in childhood. It is rarely recommended under the age of four, because in two-thirds of the cases a truss will cure. It is advised after the age of four when a truss has failed, when there is irreducible omentum, or when there is a reducible hydrocele which prevents the truss from folding (Wm. B. Coley, in "Annals of Surgery," June, 1903). The radical operation is almost without danger in properly selected cases, and is one of the most successful of surgical procedures. We are justified in doing the operation upon an individual under fifty years of age and free from complications, purely to relieve him or her from the annoyance of wearing a truss. If, however, a patient is sixty years of age or over and a truss keeps the hermia up satisfactorily, the operation should not be performed unless it is clemanded by some complication. Organic diseases of the heart, lungs, and kidneys are contraindications. Enormous herniæ (Figs. 670 and 674) are unfavorable for operation. Restoration is difficult or impossible, the forcible handling produces much shock, and recurrence is to be expected. Restoration is difficult or impossible because the abdominal cavity has contracted and holds with difficulty or cannot hold the huge hernia. As J. L. Petit said, the hernia has forfeited the right of domicile. In an operation for an enormous hernia a great quantity of omentum will require removal, and it may be necessary to resect a considerable piece of intestine. If we decide to operate upon an enormous hernia, treat the patient some time before with the object of making him lose flesh. The absorption of mesenteric fat lessens intraabdominal pressure. That operation may succeed in such cases is shown by Figs. 637 and 638. In any operation for the radical cure of inguinal hernia always remember that the bladder may be part of the hernia, and be on the lookout for it. Eggenberger's table of 6778 hernia operations shows 75 bladder hernias (1 per cent.). As a rule, it is covered with cellular fat, which differs in color and consistence from omental fat and from other fat which may be found about a hernia. The presence of a quantity of extraperitoneal fat outside of the sac suggests the adjacency of the bladder and warns us not to tie off the sac very high up. It was the author's misfortune on two occasions to open a bladder in operating upon an inguinal hernia. In each case the bladder was sutured, and both patients recovered. It has been estimated that the mortality after this accident, even when the bladder is sutured, is from 6 to 16 per cent. Among other possible accidents which may

occur during hernia operations are: injury of an iliac vessel, of a femoral essel, or of an epigastric vessel.

The success of an operation for the radical cure of a hernia de peni upon the attainment of primary union. Primary union is favored by the



Fig. 637.—Oblique inguinal hernia of large size (duration, sixteen years).



Fig. 638.—The case shown in Fig. 637 six months after operation.

cleanliness; by wearing gloves while operating; by cutting the parts with sharp knife instead of tearing them with a dissector; by removing some fall and

perfluous tissue-fragments; by tying the stitches firmly, but not tightly stitch causes necrosis and creates a point of least resistance); by careful; by dressing with pressure; and by keeping the patient recumbent for eeks.

June, 1903) has operated upon 1075 cases of inguinal and femoral In his report he does not consider operations performed within the months, and so presents a study of 1003 cases. Of these, 937 cases



Fig. 639.—Hernia which has sacrificed "the right of domicile."

guinal, 66 cases were femoral. In the 1003 cases, 647 were traced and aund well from one to eleven years after operation; 705 were well from nths to eleven years; 460 were well from two to eleven years. If tient is well one year after operation, he will probably remain well. proved by Coley's study of relapses, an investigation which shows per cent. of relapses occur within six months of operation and 80 per ithin the first year. Only 13\frac{2}{3} per cent. occur from one to two years, ly 6\frac{2}{3} per cent. after two years. Coley had 2 deaths in 1075 cases an one-fifth of 1 per cent.). After Bassini's operation there are about ent. of relapses. Coley reports that from Dec., 1891, to Jan., 1909, there reformed by Drs. Bull, Walker, and himself, in the Hospital for Ruptured

and Crippled, 2384 operations for the radical cure of hernia. Of these 2218 were inguinal (only 445 in females). In the 1773 male cases the typical or modified Bassini operation was done with 12 relapses or .68 per cent. ("Progressive Medicine," June, 1909).

Lannelongue's Method.—Lannelongue has for certain cases returned to the old injection plan, using a 10 per cent. solution of chlorid of zinc instead of white oak bark. The hernia is first reduced and is held up by an assistant who closes the internal ring with a finger, and also holds the cord aside. Several injections of 10 minims each are thrown in the region of the internal pillar, the region of the external pillar, and into the canal behind and outside of the cord. The surgeon must be careful that no zinc solution escapes



Fig. 640.—A, Hernia needles; B, hinged hernia director.

into the subcutaneous tissue. The effect of the chlorid of zinc is to cause the formation of quantities of fibrous tissue. It is scarcely to be expected that a cure so produced will be permanent in an adult, though it may be in a child.

Macewen's Operation for Inguinal Hernia.—The instruments required in this operation are scalpels, a blunt, straight bis-

toury, a dry dissector, a grooved director, scissors, a hernia director (Fig. 640, B), hernia needles (Fig. 640, A), dissecting forceps, toothed forceps, hemo-

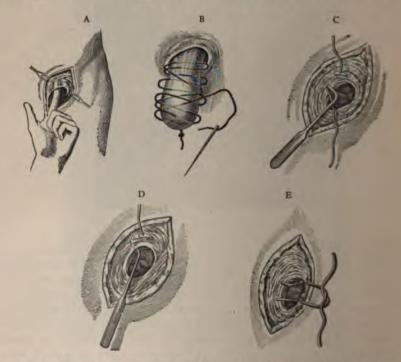


Fig. 641.—Macewen's operation for radical cure of inguinal herniat A, Stripping of the sac; B, purse-string suture; C, fastening the purse-string suture; D, passing, and E, tying, the sutures for the internal ring.

static forceps, an aneurysm needle, blunt hooks, half-curved needles, needle holder, and chromicized catgut sutures. The patient lies recumbent, the thigh being abducted and partly flexed and resting on a pillow beneath the knee. The bowel is reduced, and an incision three inches long is made in the direction of the inguinal canal, the center of the incision corresponding to the external ring. The sac is freed from its attachments below and is lifted up. The surgeon introduces a finger into the inguinal canal and separates the sac from the cord and from the walls of the canal, and then carries the finger through the internal ring and separates the peritoneum for one inch about the periphery of this aperture (Fig. 641, A). A chromicized catgut stitch is fastened to the lowest portion of the sac, and is passed through the sac several times, so that pulling on the stitch will purse the sac (Fig. 641, B). The free end of this stitch is carried through the internal ring into the belly, and is pushed out through the abdominal muscles one inch above the internal ring, the skin being pushed aside so as to escape perforation by the needle. The thread is tightened so as to fold up the sac and pull it into the belly. This plugs the ring (Fig. 641, c). The thread is handed to an assistant to keep tight until the sutures are introduced into the ring, when the sac is permanently anchored by taking several stitches in the external oblique muscle. A strong catgut suture is passed with a Macewen needle through the conjoined tendon from below upward, the ends of this suture being carried through Poupart's ligament and the outer border of the internal ring from within

outward. This suture is tightened, and closes the internal ring. The external ring is sutured and the

skin is stitched (Fig. 641, E).

In congenital hernia the sac is divided in its middle, and the lower part is closed by stitches of chromicized catgut, forming a tunica vaginalis. The upper part of the sac is slit posteriorly to permit the escape of the cord, and is closed by stitches of chromicized catgut. The operation is finished as in the acquired form (Fig. 642). After Macewen's operation the patient should stay in bed for at least three weeks, and must not work for eight or nine weeks. Workmen after this operation should always wear for a time a pad and a spica bandage. Children require no pad.



Fig. 642.—Macewen's operation for the radical cure of congenital hernia.

Never apply a truss, as strong pressure will produce atrophy of the curative scar.

Bassini's Operation for Oblique Inguinal Hernia.—(See E. Wyllys Andrews, in "Med. Record," Oct. 28, 1899, who describes from personal observation how Bassini does his operation. I have drawn upon his description in the following section.) Bassini's operation displaces the spermatic cord from the old canal and places it in a new canal, and this new canal is oblique. The instruments employed are the same as for Macewen's operation, excepting the special needles, which are not needed. Curved and rounded needles are employed to insert the stitches. The suture material is kangaroo-tendon or chromicized catgut. Silk or silver wire is apt to make trouble—it may be, long after the operation. The patient is placed supine with the thighs extended. An incision is made parallel to Poupart's ligament and extending

from the external ring to a point external to the is about one and one-half inches above the ligame inches in length. By this incision the aponeuro and the pillars of the external ring are exposed the aponeurosis is incised in the direction of its fi ward, and the inguinal canal is opened. The soblique is dissected up with a blunt instrumen is exposed. We speak of this ligament as the the sac of the hernia, the cord, the cremaster m is lifted up. Bassini employs blunt dissection. the knife. Masses of fat and usually the crem The sac is isolated first at its neck and the neck aspect of the internal ring for the distance of fobject of this stripping is to permit the removal

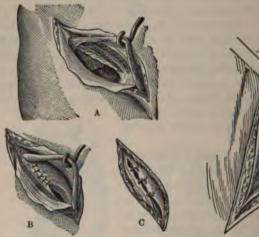


Fig. 643.—A-C, Bassini's operation for the cure of inguinal hernia.

Fig. 644.—Bass

High removal obviates the leaving of a funnel-toneum. Such a depression predisposes to relap the fundus, the interior is investigated, and if they are restored to the abdominal cavity and the high up. If adherent masses of omentum are separated, bleeding is arrested, and the omentum men unless it is in a hard and thick mass, when Bassini ties off the neck of the sac above the clof silkworm-gut. If the sac is large and thick, of a ligature upon a needle, passes the strand that around over the first loop. (See E. Wyllys Andra 28, 1899.) Dr. Coley and many other operators procatgut suture rather than with silkworm-gut or silk employ fine black silk, catching it to prevent silthrough the wall of the neck of the sac. After light

sac is cut across and removed. The cord is now lifted out of the way (Fig. 643, A), the inner surface of Poupart's ligament is exposed by retraction, and the deep sutures are passed (Fig. 643, A). Bassini uses silk which has been boiled in glycerin. Most American operators use kangaroo-tendon or chromicized catgut. Bassini inserts first the sutures nearest to the pubes. The first suture—and sometimes also the second—includes part of the rectus sheath and rectus muscle. Each stitch includes the internal oblique and transversalis muscle in the upper edge and the shelf of Poupart's ligament below the lower margin, and from four to six stitches are passed behind the cord (Fig. 643, B). The last stitch narrows the internal ring so that it fits tightly around the cord (E. Wyllys Andrews, "Med. Record," Oct. 28, 1899). Coley's rule for passing this suture is to insert it so "that it just touches the lower border of the cord

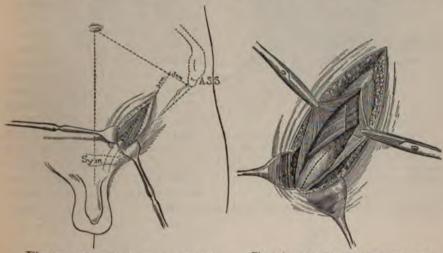


Fig. 645.—The skin incision, retractors in the lower angle of the wound dislocating the opening in the skin and subcutaneous fat downward, exposing the aponeurosis of the external oblique and external ring. The dotted line within the wound represents the direction of the division of aponeurosis of external oblique (Bloodgood).

Fig. 646.—The aponeurosis of external oblique has been divided and retracted, uncovering the internal oblique muscle and inguinal canal. The lines on the muscle represent the direction and extent of the division. The dotted line in the inguinal canal is the direction and extent of the division of the coverings of sac (Bloodgood).

Surgery," June, 1903). Coley always places a suture above the cord, delieves it tends to prevent relapse (Fig. 644). The sutures are tied me above downward. The cord is laid upon this new floor and the aportrosis of the external oblique is sutured over it (Fig. 643, c). Coley uses continuous suture of fine kangaroo-tendon and closes the skin with interted sutures of catgut. Drainage is not used. The wound is covered a roll of iodoform gauze and some pieces of sterile gauze, and compression that has the other acts as a shelf for the testicles to rest upon. The adhesive ster is overlaid with dry gauze, and this is covered with absorbent cotton the dressing is retained in place by a firm spica of the groin (Coley's sing). The wound is dressed on the seventh day and the patient is kept

in bed for two weeks and is allowed to get about in two and one-half weeks to three weeks, wearing a bandage until four weeks after operation.

In this operation some surgeons treat the sac as in Macewen's operation. carrying out the rest of the procedure as directed above. In a pure Bassini operation the funnel-shaped depression in the peritoneum at the point of emergence of the cord may remain and predispose to hernia, but the use of

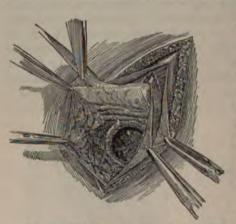


Fig. 647.-The internal oblique muscle and the coverings of the sac have been divided, the sac with the veins and vas deferens are drawn out of the wound preparatory to the excision of the sac and the ligation and excision of the veins (Bloodgood).

Macewen's plan for treating the sac obviates this.

Halsted's Old Operation (as described by J. C. Bloodgood, in "Johns Hopkins Hosp, Report," vol. vii). - The skin incision is not parallel to Poupart's ligament, but at an angle of 25 degrees to it (Fig. 645). Poupart's ligament is well exposed to within 2 cm. of the pubic spine. The aponeurosis of the external oblique muscle is divided. Free the lower border of the internal oblique muscle and divide the edge of the muscle at a right angle to its fibers (Fig. 646), and as far as possible from the linea semilunaris. The coverings of the sac near the neck are picked

up with mouse-toothed forceps and are divided. The division of the

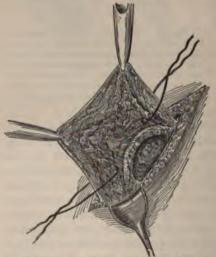


Fig. 648.-The method of excision of veins in operations for hernia and varicocele. The vas

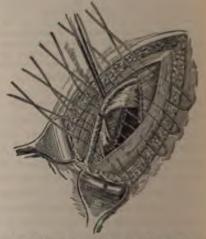


Fig. 649.-The insertion of the deep silver wire sutures, one above and four below the deferens and its "immediate" vessels and the cord. The veins have been ligated and ex-mesocord have not been disturbed (Bloodgood). cised. The mesocord has been torn gently in its center only (Bloodgood).

fasciæ is continued from the neck of the sac downward toward the pube

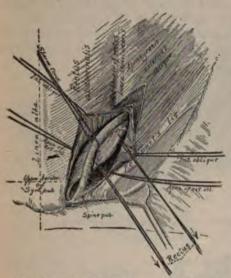


Fig. 650.-The method of transplanting the rectus muscle. The sac has been excised and the peritoneal cavity closed; internal oblique muscle has been divided, the rectus exposed and transplanted; at this stage the wound is ready for the deep sutures. This illustration shows how perfectly the transplanted rectus muscle lines the lower half of the wound (Bloodgood).

is used to tear the mesocord. of the divided internal oblique muscle, and is held there until the sutures are inserted. The deep sutures of silver wire are next inserted. Usually five are needed. The upper one is passed first. These sutures are shown in Fig. The cord emerges from the cut in the internal oblique muscle between the first and second sutures. Sutures No. 1 and No. 2 pierce the mesocord, but care is taken to see that they do not injure the vas or its vessels. uture is drawn upon and twisted bout six times. The cut twisted ends e caught with forceps and turned The skin-wound is closed th a subcuticular stitch of silver dry gauze, and often a plaster- more clearly (Bloodgood).

The sac is then lifted from the inguinal canal and it bring with it "the larger bundle o veins and the vas deferens" (Fig. 647). The sac is separated from the veins and the vas with a knife or scissors, and the separation is carried to and beyond the neck of the sac. In "certain cases the larger bundle of veins is separated from the vas deferens, ligated, and excised" (Fig. 648). Whether the veins are excised or not, the sac is opened, its contents reduced, the opening into the peritoneal cavity closed with a continuous silk suture, and the excess of sac excised. During the entire operation the vas and its vessels "should be handled very little, and should not be torn from their bed in the inguinal canal." Every point of bleeding should be ligated. At this stage the vas is gently picked up and a blunt-pointed hook The freed vas is lifted into the upper angle

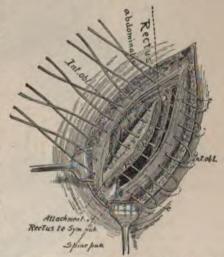


Fig. 651.-The transplanted rectus included by e. It is covered with silver-foil the deep sutures. In this illustration the cord has been excised in order to demonstrate the operation

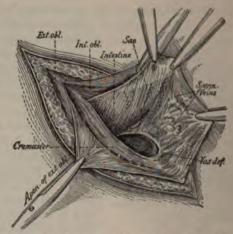


Fig. 652.-Exposure of the sac, the vas, and the spermatic veins (Halsted).

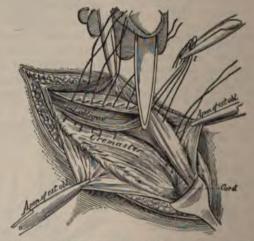


Fig. 653.-Suture of the cremaster to the internal oblique (Halsted).

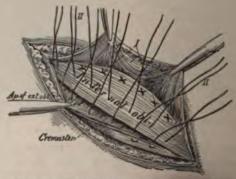


Fig. 654.-Suture of the lower edge of the internal oblique to Pomart's Egament (Halsted).

of-Paris bandage and splints are used, "the splints extending from just above the knee to near the costal margins."

The Modified Halsted Operation.—The operation at present performed by Professor Halsted and his assistants has been evolved from the former operation so long associated with his name, and has been greatly modified

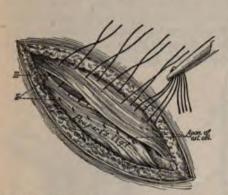


Fig. 655.—Suture of the aponeurosis of the external oblique (Halsted).

by himself and by Dr. Bloodgood. In this operation the skin and the aponeurosis of the external oblique are incised exactly as in performing Bassini's operation; and flaps of aponeurosis are raised. Next, the cremaster muscle and the cremaster fascia are incised in a line slightly above the center of the spermatic cord. The internal oblique muscle is then brought into distinct view at the side of the inguinal canal, and the hernia is carefully inspected (Fig. 652). If the veins are found to be large, they should be excised; but the surgeon does not lift the vas

from its bed, and even avoids touching it, if he possibly can, for fear that thrombosis may occur in its veins. The veins are tied above, well up in the abdomen; and below, well above the testicle, and excised between the ligatures. The sac is then ligated or sutured with a purse-string suture. One end of the thread that ties or sutures the sac is carried, by means of a long, curved needle, in an

outward direction under the internal oblique muscle, through which it is then pulled. The other end of the thread is also pulled through the muscle, oneeighth of an inch from the first end; and these two ends are tied together. It will be observed that this treatment of the neck of the sac is somewhat similar to the method practised by Kocher.

The next step is to carry the inferior flap, composed of cremaster muscle and fascia, under the internal oblique muscle, and suture it there (Fig. 653). We

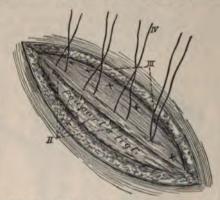


Fig. 656.—Suture of the margin of aponeurosis to Poupart's ligament (Halsted).

next suture the internal oblique muscle and the conjoined tendon to Poupart's ligament, the lower edge of the internal oblique being tucked under the edge of the ligament (Fig. 654). In order to accomplish this, it may be necessary to release the muscle by incising the anterior rectal sheath. The incision in the external oblique is now closed with sutures that overlap the margins (Figs. 655 and 656), and the skin wound is also closed. Halsted's Operation plus Bloodgood's Method of Transplanting the Rectus Muscle.—(See Jos. C. Bloodgood, in "Johns Hopkins Hosp. Reports," vol. vii.) When the conjoined tendon is very thin or obliterated, the ordinary operation is not enough. Insufficiency of the conjoined tendon is known to exist when a finger does not meet any obstruction after passing through the external abdominal ring, but can be introduced for some distance into the abdominal cavity (Bloodgood). To meet this condition of affairs, Bloodgood devised "a plastic operation on the rectus muscle, bringing this muscle down and suturing it with the other available tissue to Poupart's ligament and to the aponeurosis of the external oblique from the arch of the pubis up to

the position of the transplanted cord" (Bloodgood, in previously mentioned report). The first steps of the operation are identical with those previously described, but before the insertion of the deep stitches the rectus sheath is exposed and divided in the direction of the muscle-fibers, from the pubic insertion upward for 5 cm. The muscle bulges from the cut and is caught with silk sutures (Fig. 650). Deep sutures are now introduced as in

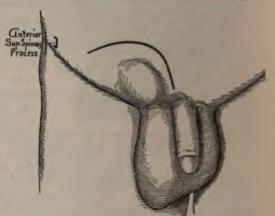


Fig. 657.—Ferguson's operation: the semilunar skin incision ("Jour, Am. Med. Assoc.").

Halsted's operation, except that they include the rectus and its sheath (Fig. 651). The operation is completed as is Halsted's. I have performed this operation a number of times with entire satisfaction.

Kocher's Operation.-Kocher exposes the aponeurosis of the external

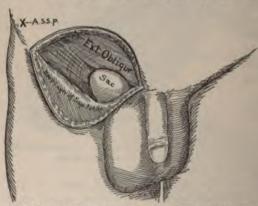


Fig. 658.—Ferguson's operation: flap turned back exposing the aponeurosis and the sac of the hernia ("Jour. Am. Med. Assoc.").

oblique, makes a small incision through the aponeurosis above and external to the internal ring, and draws the sac through this incision and sutures it in place.

Fowler's operation is as follows: an incision is made parallel with Poupart's ligament from the spine of the pubis to the level of the internal ring, and a flap is turned up. The inguinal canal is opened and the sac and cord are isolated. The sac is opened, its contents

reduced, it is cut off, and its edges grasped with forceps. The deep epigas-

tric artery and vein are sought for, each is tied in two places and divided between the ligatures. The index-finger is introduced into the belly, and on this as a guide the floor of the canal is divided (transversalis fascia, subserous tissue, and peritoneum). The cord is placed in the peritoneal cavity. The edges of the opening are sutured so that broad serous surfaces are approximated, through-and-through sutures being passed from side to side. The cord is brought out at the inner end of the incision, the lower angle of the cut being at such a level that the cord curves upward and forward as it leaves the abdomen. The inguinal

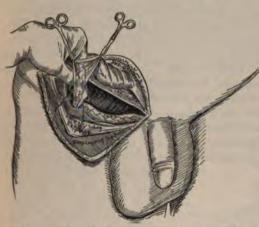


Fig. 659.—Ferguson's operation: dealing with the sac and its contents ("Jour, Am. Med. Assoc.").

canal, the gap in the aponeurosis, and the skinwound are closed.\*

Ferguson's Operation .-In studying a number of recurrences after operation A. H. Ferguson observed that a hernial protrusion is apt to return at the upper and outer portion of the scar, above the cord and near Poupart's ligament. When he operated upon relapsed cases, he discovered a slit of the aponeurosis of the external abdominal wall, through which the sac and some fat protruded. In order

to determine the cause of the failure of these operations, he thought it proper to make a semilunar incision, and raise a flap of skin, fascia, and aponeurosis

of the external oblique. On doing this, he was surprised to find an angle between the lower border of the internal oblique muscle and the inner aspect of Poupart's ligament absolutely unprotected by the internal oblique or the transversalis muscle. In some cases this angle extended upward and outward to the anterior superior iliac spine. He therefore determined positively that the cause of a rupture returning in this

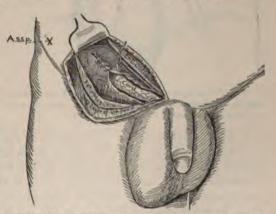


Fig. 660.—Ferguson's operation: suture of the slack in the transversalis fascia (" Jour. Am. Med. Assoc.").

angle after an operation for radical cure is deficient origin of the internal ob-

\*Annals of Surgery, Nov., 1897.

lique muscle and of the transversalis muscle at Poupart's ligament. He is now persuaded that in all cases of hernia there is a deficient origin of these muscles, and he has demonstrated the same thing in a series of dissections in the inguinal region. Ferguson describes his operation as follows ("Jour. Am. Med. Assoc.," July 1, 1800): He begins his incision over Poupart's ligament, an inch and a half below the anterior-superior iliac spine, carries it inward and downward in a semilunar curve, and terminates it over the conjoined tendon, near the pubic bone. This incision goes down to the aponeurosis of the external oblique, and the flap, with its fat and fascia, is turned downward and outward (Figs. 657 and 658). The next step is to incise the external abdominal ring to the intercolumnar fascia and separate the longitudinal fibers of the external oblique over the inguinal canal to beyond the internal ring. at a point nearly opposite the anterior-superior spine of the ilium. Any transverse fibers that may be encountered are severed. The separated aponeurosis of the external oblique muscle is then retracted. One has then brought into view the contents of the inguinal canal, the hernial sac and its adhesions, the spermatic cord, the ilio-inguinal nerve, the internal abdominal ring, the subserous fat, the cremaster muscle, the conjoined tendon, the internal oblique and its deficient origin at Poupart's ligament, the transversalis fascia, and the internal surface of Poupart's ligament. The sac is now dissected from the cord and the internal ring. It is opened and its contents are inspected and

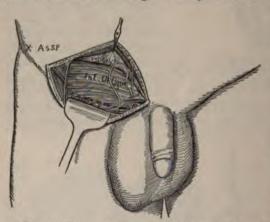


Fig. 661.—Ferguson's operation: suture of the internal oblique and of the transversalis muscle to the internal aspect of Poupart's ligament ("Jour. Am. Med. Assoc.").

properly dealt with. It is tied high up and cut off, and the stump is dropped into the abdomen (Fig. 659). If the sac is congenital, it is divided into two parts: the distal portion is used to make a tunic for the testicle, and the proximal portion is treated as above directed. The cord is not disturbed, and it is beyond doubt that Ferguson is right in saving that the testicle frequently comes to harm after operations that disturb the cord. veins in the cord should

not be touched unless a varicocele also exists. Any excessive quantity of subserous adipose tissue should be removed. The next step in the operation is to restore the structures to their normal position; and one should remember that in the transversalis fascia is the internal ring. In hernia the internal ring is large and the transversalis fascia bulges outward; one must, therefore, take up the slack in this fascia and make a well-fitting ring for the cord, by means of a catgut suture, either interrupted or continuous (Fig. 660). After this has been accomplished, the internal oblique and transversalis muscle are sutured to the internal aspect of Poupart's ligament, after the lower borders of the muscles have been freshened and Poupart's

ligament has been scarified. The sutures must be carried two-thirds of the way down Poupart's ligament, which is about the normal origin of this muscle in the female (Fig. 661). The next step is to suture the edges of the divided aponeurosis of the external oblique; this restores the external abdominal ring. The skin-flap is then carefully sutured.

Radical Cure of Direct Inguinal Hernia.—If the hernia goes through the conjoined tendon or pushes that structure before it the operation should consist in transplanting the rectus muscle as practised by Bloodgood (page 1138) and suturing the arched fibers of the internal oblique and conjoined tendon to Poupart's ligament and beneath the cord.

If the hernia passes around the outer edge of the conjoined tendon an overlapping operation, like the Mayo operation for umbilical hernia, should be performed (G. G. Davis, in "Annals of Surgery," Jan., 1906).

Radical Cure of Umbilical Hernia.—The results of operations for umbilical herniæ have not been satisfactory. Recurrences are frequent. This is prob-

ably due to the fact that most of the subjects are fat, and that the muscles are thin and flabby. The usual operation may be thus described: Make a Longitudinally elliptical incision through the skin around the mass. cleavor to separate the sac From the superficial tissue. If this cannot be done, open the sac and separate It from the contents. Even if the sac can be stripped From the skin, always open it and separate the contents. Return any bowel which may be present, and do not forget that there may be a small portion of bowel completely encased in omentum. Tie into segments and cut off the su-

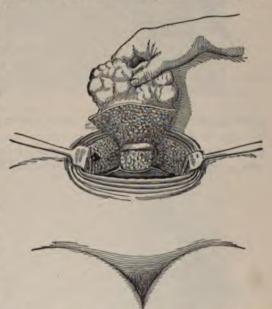


Fig. 662.—Mayo's operation for the radical cure of umbilical hernia. Exposure of hernia and lateral incision.

perfluous omentum and return the stump into the belly. Excise the umbilicus (omphalectomy). Suture the peritoneum with a continuous catgut suture. Close the musculofascial wall with two layers of interrupted kangaroo-tendon sutures or one layer of silver wire mattress sutures. Close the skin by interrupted sutures of silkworm-gut or a subcuticular stitch.

Mayo's Operation.—This is a vast improvement on the older operation. It gives a firm cicatrix free from disastrous traction. Mayo believes that the defect in the old operation is that the recti muscles are naturally separated at the level of the umbilicus, and in bringing the recti together we have virtually performed muscle transplantation, and these thin muscles are of no great value

in preventing relapse, and in a large hernia it is not gap by muscle. Mayo now operates as follows: Tr are made around the umbilicus and hernia and th exposed (Fig. 662). The surface of the aponeuro

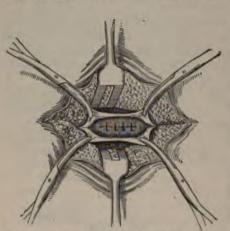


Fig. 663.—Mayo's operation for the radical cure of umbilical hernia. Peritoneum sutured.

one-hal the sac. neal co divided around Intestin and pla Omenti with the ring ar in orde it can l is the d cated. the fibr ings of transve the per the un

flap. Several mattress sutures of silver wire are the edge of the upper flap and are carried through flap; sufficient traction is made to permit of the with a continuous catgut suture (Fig. 663). Wi

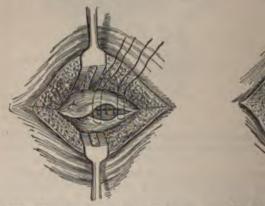


Fig. 664.—Mayo's operation for the radical cure of umbilical hernia. Aponeurosis sutured.

Fig. 665. cure of umbit second time

plished, the silver wire sutures are drawn so as the pocket between the peritoneum and the under (Fig. 664). The free margin of the upper flap is the aponeurosis (Fig. 665), and the superficial incision

J. Mayo ("Jour. Am. Med. Assoc.," June 1, 1907) reports upon 88 operations for umbilical hernia by this method between 1894 and 1905. Seventy-five



Fig. 666.—Fabricius's operation for the radical cure of femoral hernia. Neck of sac shown. Sac cut away. Dotted line shows line of separation of Poupart's ligament and fascia lata (Fowler).

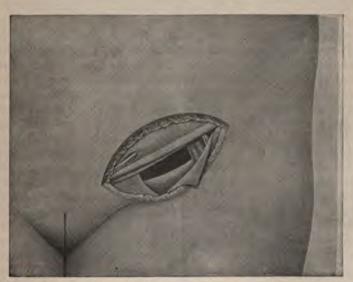


Fig. 667.—Fabricius's operation for femoral hernia. Fascia lata turned back, exposing crural sheath and origin of pectineus muscle (Fowler).

were traced. One had a partial relapse. One was supposed to have a relapse, but operation disclosed a second opening above and outside of the closed umbilical opening.

Radical Cure of Femoral Hernia.—Cheyne ligate stitches the stump to the abdominal wall, dissects of tineus muscle, stitches this flap to Poupart's ligament

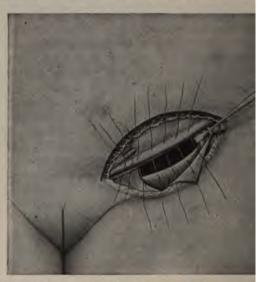


Fig. 668.—Fabricius's operation for femoral hernia. Crural sheath garoo-tendon sutures applied to Poupart's ligament and origin of per sutures are placed in position to approximate the pillars of the externs

wall, and thus fills up the crural canal. Bassini ma with Poupart's ligament, ties the neck of the sac, of and returns the stump into the belly. He attaches by ligament to the pectineal aponeurosis as high up as

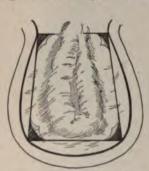


Fig. 669.—Outline of peritoneal lining of sac utilized as a flap to cover posterior surface after it has been freed by dissection (Weir).

the cord or round liga of the way. Superfic between the pubic porti of the fascia lata.

The Operation of I tion of Fabricius is very performed as follows: A the pubic spine and is calcinches parallel with Posac is exposed, isolated, at tents are reduced, its necut off, and the stump 666). An incision is repart's ligament so as to and the fascia lata fascia is turned down (

sheath and the vessels are retracted outward. The to injure the obturator artery and vein. The origin of is sutured to Poupart's ligament. The lower stitches of the horizontal ramus of the pubes as well as the beginning of the muscle (Fig. 668). Care must be taken in passing some of them to avoid injuring the deep epigastric vessels. When these stitches are tied, the femoral canal is obliterated. The flap of fascia lata is sutured to the aponeurosis of the external oblique, and the skin is sutured.

Operative Treatment of Sliding Hernia of the Ascending and Descending Colon.—My personal experience consists of four cases of right and one case of left inguinal hernia. The sac is deficient posteriorly and externally (page 1155). In order to restore the bowel many operators have sought to force up the adherent bowel to the external ring, and others have stripped the bowel from the subperitoneal tissues in order to permit of reduction. This first plan should never be followed, as sutures will fail to hold the bowel up. The second plan is risky and may be followed by gangrene of the bowel. In my cases I followed Wier's plan ("Med. Record," Feb. 24, 1900), and after dissecting up the peritoneum on each side to a little above the internal ring, reed the bowel from its bed, and covered the new surface with the peritoneal laps (Fig. 669). The bowel was then restored and a radical cure was made.

Irreducible Hernia.—The swelling in irreducible rupture presents the isual evidences of hernia, imparts an impulse on coughing, but cannot be replaced in the abdomen. Sometimes a portion is reducible and a portion is reducible. A hernia may become irreducible because of the size of the mass, because of adhesions, or because of excessive growth of omental fat. An irreducible hernia is liable to be bruised and to cause much distress and pain, and is always a menace to life because of the danger of obstruction and strangulation. It was formerly the custom to support a small irreducible hernia by a hollow, padded truss, but at present operation is advised. A large hernia of this variety, if operation is refused, must be carried in a bag truss. The patient must not take very active exercise, must keep the bowels regular, and must live upon a plain diet. Most cases of irreducible hernia should be treated by operation.

Incarcerated or Obstructed Hernia.-Obstruction takes place by the damming up of feces or of undigested food, the fecal current being arrested, but the blood-current in the wall of the bowel not being cut off. Incarceration is commonest in irreducible hernia, umbilical hernia, and during the existence of constipation. The hernia enlarges and becomes tender, painful, and dull on percussion; pressure diminishes it in size; it is irreducible, but still presents impulse on coughing. The abdomen is somewhat distended and painful; there are nausea, constipation, and not unusually slight vomiting. Constitutional disturbance is trivial and constipation is not absolute, gas at least usually passing. Vomiting is not fecal. The treatment is rest in bed in a position to relax the belly, an ice-bag over the hernia for a very few hours, and a little opium for pain. Do not give a particle of food for twentyfour hours; when the active symptoms subside, give an enema, and after this acts a dose of castor oil. Do not employ taxis, as bruising the bowel may produce strangulation. If improvement does not rapidly occur, operate. Prompt operation saves the patient from the danger of strangulation and cures the hernia.

Inflamed Hernia.—Inflammation of a hernia is local peritonitis due to injury of an irreducible hernia. The mass becomes tender and painful,

and perhaps heat is noted. In enterocele much fluid forms; in epiplocele the mass becomes hard. The hernia cannot be reduced; there is constipation, often vomiting, usually elevated temperature, but the mass still shows impulse on coughing. Vomiting is not fecal. Some gas is usually passed through the bowels. Constitutional symptoms are slight. The treatment usually recommended is rest in bed with abdominal relaxation, an ice-bag to the tumor for a few hours, a small amount of opium by the mouth if pain is severe, an enema, and, after this acts, a saline. In an inflamed hernia there is great danger of strangulation, and operation should be performed in preference to relying upon the conservative plan.

Strangulated hernia is a condition in which, if the hernia contains bowel, not only is the fecal circulation arrested and gas prevented from passing, but the circulation of blood in the bowel-wall is also arrested. The bowel is irreducible and obstructed, and the blood ceases to circulate. If the hernia contains omentum, the omental vessels are tightly constricted. In both



Fig. 670.—Strangulated umbilical hernia containing nearly all the intestines and part of the stomach. Strangulation under bands within the sac.

bowel and omentum gangrene soon occurs, but sooner in bowel than in omentum. Strangulation is commonest in old inguinal ruptures in active, middle-aged men, and is more frequent in enteroceles than in epiploceles. It is most common when the hernial orifice is small and is seldom seen in large ruptures. Strangulation is much more dangerous if bowel is present in the sac than if only omentum is present. If the abdominal pressure is suddenly increased, as by a violent cough or a muscular effort, the hernial orifice is dilated for a moment, more intestine or omentum may enter the sac, and if it does, it may be caught and constricted by the now constricted hernial orifice and strangulation begins. Strangulation so caused is called elastic strangulation. A sudden increase of

<sup>\*</sup>Strangulation developed in the large hernize shown in Figs. 637 and 670.

Intra-abdominal pressure may force a quantity of fecal matter into the hermiated intestine. The sudden entry of a quantity of fluid and gas into the berniated coil causes fecal strangulation, the mechanism of which is obscure. By retrograde strangulation we mean a condition in which the end of a loop of Dowel or a piece of omentum in a hernia re-enters the abdomen and then beomes strangulated, the balance of the hernia not being strangulated. Strangu-Lation may be due to active peristalsis or to congestion, and it may arise from Inflammation or from incarceration. The constriction may be at the neck of The sac, in the outside tissues, or even in the sac itself. In an hour-glass hernia the constriction is in the body of the sac. In inguinal hernia a tight external Fing is a common cause of strangulation and is the commonest cause in children. As Coley shows, the neck of the sac is very seldom the cause in children. Adhesions within the sac may cause strangulation. Spasmodic Contraction of the tissues about the neck of the sack is an exploded hypothesis. The obstructed veins dilate and the blood in them ceases to move, the bowel becomes deep bluish and finally black, effusions of blood occur beneath the peritoneum, and the intestinal wall becomes edematous. Fluid transudes

into the sac, and the fluid, at first clear, assumes a bloody hue, and finally becomes dry and foul. The peritoneum ceases to glisten, becomes dry and rough, and coated here and there with lymph. Strangulated omentum undergoes edema and hemorrhagic infarction and thrombosis occurs. When strangulation once begins, the hernia swells, a furrow forms on the bowel at the seat of constriction, the bowel and omentum below the constriction become deeply congested and edematous, and, finally, the hernia passes into



Fig. 671.—A strangulated coil of intestine after the strangulation existed for a considerable period of time. The color has become almost black and the peritoneal surface is dull and covered with flakes of fibrin. The constriction-rings are deeply sunken, their walls markedly thinned, relaxed, and dirty gray in color. Both constriction-rings are gangrenous and hemorrhages are observed in the mesentery (Sultan).

a state of moist gangrene (Fig. 671). The gangrene may be in spots or the entire mass may be gangrenous. The mucous membrane may be gangrenous when the serous coat looks fairly sound. When gangrene is once established, the bowel is in danger of rupturing. At the point of constriction there may be a line of ulceration or of gangrene. A strangulated femoral hernia becomes gangrenous more rapidly than does a strangulated inguinal hernia.

Symptoms.—This condition is sometimes preceded by diarrhea and uneasiness or pain about the hernial orifice. When strangulation begins, the victim is seized with pain in and about the hernia and with violent colicky pain about the umbilicus, and the paroxysms of colic become more and more frequent, until finally the pain may become continuous. The hernia is found to be irreducible; larger than usual, tender, painful, dull on percussion, without impulse on coughing, and the skin above it may be red-

dened. Eructations of gas are frequent and generally uncontrollable vomand prostration come on. Vomiting, as a rule, is an early symptom, and which increases in severity. Occasionally it only follows the swallowing of liquids. Not unusually there is retching rather than vomiting. In rare vomiting does not begin for twenty-four to forty-eight hours. During course of a strangulation vomiting may cease for a day or more, and it unusually ceases toward the end, when prostration is profound. The vomiting is due to reflex causes; the later vomiting is due to waves of p stalsis which produce regurgitation (Macready). The vomiting is first and of the alimentary contents of the stomach, next of mucus and bilious matter atternation and finally of the contents of the small bowel (fecal or stercoraceous vomiting sting) Stercoraceous vomiting rarely arises until strangulation has lasted forty-eight cight hours, and may not appear until much later. "It is seldom met with self-in inguinal, more often in femoral, and more often still in obturator hernia and (Macready). Prostration is a marked symptom of a strangulated herreand it increases hour by hour and goes on to collapse. Early in the there may be some elevation of temperature, but later it becomes normal or subnormal. The pulse is small, irregular, rapid, and very weak: extremities cold; the face Hippocratic. Constipation is absolute, no gas evbeing passed, though in the very beginning there may be some diarrhead passages from below the constriction. The urine is scanty and high-colors and contains only a small amount of the chlorids; the tongue becomes day and brown; the thirst is torturing; and the patient often has an imperative desire to go to stool. Pains in the abdomen and in the hernia become more and more violent, and collapse rapidly increases. When gangrene begins the symptoms apparently lessen in violence: there is a "delusive calm Vomiting usually ceases, though regurgitation may take its place; hiccour begins; the pain abates or disappears; the pulse becomes very frequent, feeb and intermittent; collapse deepens, and delirium is usual. It is a safe clinic rule that in strangulated hernia cessation of pain without the relief of corstriction, the disappearance of the lump, or the use of opiates means the gangrene has begun. In some cases of strangulation there are muscula cramps in the legs (Berger). In children convulsions are not unusual. In a pure omental hernia strangulation produces similar but less decided symptoms. It may be that only a portion of the circumference of the bowel is caught and constricted in a hernial orifice (Fig. 678, A). Such a condition is encountered occasionally in the femoral ring, and is called partial enterocele or Richter's hernia. The name Littré's hernia is often wrongly given to this condition. What Littré described was a hernia of Meckel's diverticulum (Fig. 678, B). In a strangulated Richter's hernia constipation is rarely absolute and a protrusion is often undiscovered.

Treatment.—In treating strangulated hernia place the patient upon his back, bend the knees over a pillow, and rigidly interdict the administration of food. An attempt is to be made to effect reduction by gentle manipulation or taxis. In applying taxis to a femoral or inguinal hernia, flex and adduct the thigh of the affected side. In applying taxis to an umbilical hernia, both thighs should be flexed upon the abdomen. Always lower the shoulders and head and raise the pelvis, and accomplish this by lifting the foot of the

bed and placing pillows under the pelvis. In some cases raise the entire body and lower the head. Grasp the neck of the sac with the fingers and thumb of one hand, and employ the other hand to squeeze the hernia and urge it toward the belly. In direct inguinal hernia the pressure should be backward and a little upward; in umbilical hernia it should be backward; in oblique inguinal hernia it should be upward, outward, and backward; in femoral hernia it should be downward until the hernia enters the saphenous opening, and then "backward toward the pubic spine" (MacCormac). If the bowel is reduced, it passes from the hand with a sudden slip and enters the belly with an audible gurgle; omentum, when reduced, slowly glides back without gurgling. Taxis is never to be continued long, and it is not even to be attempted in cases of great acuteness, in cases where strangulation has lasted for several days, in cases known to have been previously irreducible, in cases associated with stercoraceous vomiting, or in inflamed or gangrenous herniæ.

If taxis fails, obtain the patient's permission to operate. Anesthetize; try taxis again while ether is being dropped upon the hernia to cause cold; if reduction fails, at once perform herniotomy. Taxis possesses certain dangers: It may rupture the bowel; it may rupture the neck of the sac and force the bowel through the rent into the tissues of the abdominal wall; it may strip the peritoneum from around the hernial orifice and force the bowel between the detached peritoneum and the abdominal wall; it may reduce a hernia into the belly when the bowel is still strangulated by adhesions; it may reduce the hernia en masse or en bloc. By the term reduction en masse we mean that the sac has been separated and dislocated and with the constricted bowel within it has been forced through the internal ring. By reduction en bissac is meant the forcing of a congenital hernia into a congenital pouch or diverticulum. Reduction en masse is a rare accident. Corner and Howitt collected 137 cases of reduction en masse of strangulated hernia ("Annals of Surgery," vol. xlvii). Of these 110 were males; 113 were inguinal, 22 femoral, and 2 obturator. No ventral or umbilical cases are recorded. The accident is a very dangerous one. According to Corner and Howitt (Ibid.) the mortality after inguinal reductions en masse is 48 per cent., and after femoral reductions, 72 per cent. Strange to say, reduction en masse can occur spontaneously. The subject most liable to reduction en masse is an elderly person with an old hernia. In acute cases the small bowel is the viscus which was reduced. In subacute and chronic reductions en masse the omentum, large bowel, or bladder was reduced (Corner and Howitt, Ibid.). Subacute and chronic cases may happen in non-strangulated hernia. In any of the above accidents obstruction may persist after apparent reduction by taxis. Persisting obstruction means strangulation or peritonitis and calls for instant laparotomy—in most instances through the hernial aperture. If taxis is successful, put the patient to bed, apply a pad and bandage, allow no food until vomiting ceases, merely permit him to take a little hot water for twenty-four hours, and keep him on a liquid diet for several days. At the end of the first week give solid food. Do not disturb the bowels for a few days, but if they have not acted when four or five days have elapsed since the operation, give a saline cathartic and an enema. There is usually a spontaneous movement within twenty-four hours.

Herniotomy.-If there has been stercoraced

during should eral and cases it and a Schleich In most patient dropped taxis if fails, at strumer knife (F dissection partly of buttons the open shoulderight singular custom skin at transfix it become should be transfix

Fig. 672. — Cooper's curved herniotome.

must be washed out before during the administration of should be turned upon its si eral anesthetic can be give cases it is not justifiable to and a local anesthetic must Schleich's fluid). Wrap the In most cases try gentle taxis patient has been anesthetized dropped upon the hernia taxis if stercoraceous vomit fails, at once sterilize the pa struments required in herniot knife (Fig. 672) and director ( dissecting forceps, retractors partly curved needle, a n buttons. Drainage-tubes sl the operation the patient lie shoulders raised, the surgeon right side. In oblique ingui custom since the days of Sc skin at a right angle to the a: transfix it, the wound which it becomes three inches in sesses no special merit. It inward, and to make the sa

formance of a radical cure in a non-strangulated

sues are divided, the aponeurosis is opened as in Bassini's operation and the sac is reached. In most cases the constriction is relieved as soon as the external ring is nicked, and in many cases fibrous adhesions will be found in that region, gluing the sac to the ring. The sac must be identified; and it is known by the fat which usually covers it, by the arborescent arrangement of its vessels, by the fact that it can be pinched up between the finger and thumb, and the layers rolled over each other, and by the fluid within the sac. Should



Fig. 673.—The division

the sac be opened? It may not be actually nece but if there is any doubt as to the condition of the

to be attempted, open the sac and be certain as to the condition of its contents. As there is always some doubt as to the condition of the contents, and as a radical cure is to be made, make it a rule to always open the sac. The sac is opened and the contents examined for fecal odor (which is not unusual) and for gangrenous smell; the thickness of the bowel is estimated and the color and lustre are determined. If a constriction exists at the neck the constriction is nicked with a hernia knife. In oblique inguinal hernia nick the constriction upward and outward or directly upward, as shown in Fig. 673. In direct inguinal hernia the cut is made upward and inward. Always pull the bowel down and examine the seat of constriction to see what damage has been inflicted at that point. If the bowel glistens; if the proper color comes back after irrigation with very hot water; and if there are no spots of gangrene, restore the bowel to the abdomen and do a radical cure. If the bowel is in a doubtful condition, fasten it to the incision, apply a dressing, and watch the development of events. If the bowel is gangrenous, our action depends upon the condition of the patient. If the patient is in good condition, resect the gangrenous portion, and perform end-to-end approximation If the patient's condition is bad, draw the gangrenous portion well out, anchor it to prevent leakage and retraction, make an artificial anus, and at a later period perform anastomosis. An artificial anus can be made by the method of Bodine (page 1112). Unfortunately in these cases the artificial anus must usually be made in the small intestine. In many cases in which there is some uncertainty as to the need for an artificial anus prepare the bowel for the opening, but do not open at once, because the bowel may recover in a day or two, when it can be restored to the belly; or it may slough and form an artificial anus. In such doubtful cases fasten the bowel to the belly wall with sutures, dust it with iodoform, dress it with hot antiseptic fomentations, and await future developments. Gangrenous omentum requires ligation and resection. If the bowel is fit to reduce, push it just inside the ring, irrigate the parts, suture, and perform a radical cure. In femoral hernia we can make the incision one inch internal to, and parallel with, the femoral vessels, and crossing the tumor and ligament (Barker); but it is better to make the incision of Fabricius for radical cure. Divide the constriction by cutting upward and a little inward. If the gut is found gangrenous or in a doubtful condition follow Blake's advice ("Surg., Gynecol., and Obstet.," May, 1906), make an incision at the edge of the rectus, draw the affected portion of gut into the abdomen and out of the incision and either resect, fix it under or out of the incision, or wait for return of circulation, as may be indicated in the case. To draw the gut out of the femoral ring makes so much traction that return of circulation may be prevented and any intestinal operation is difficult in this region without splitting Poupart's ligament. In umbilical hernia make a slightly curved incision a little to one side of the middle of the tumor, open the sac, separate adhesions, and divide the constriction by cutting upward or downward, and sometimes also laterally.

After an operation for strangulated hernia put the patient to bed; bend the knees over a pillow; give no food by the mouth for thirty-six hours (Mac-Cormac), only allowing hot water, and give an enema of salt solution containing brandy every sixth hour. Abdominal pain and tenderness call for the administration of saline cathartics and enemata containing turpentine or oil of rue. The enema rutæ is a favorite preparatic London. It is made as follows: Take sixteen ou mile, warm it, and pour it upon 3iij of confection are no abdominal pain and tenderness, the bowe a few days; but if at the end of four or five day a saline cathartic and an enema. At the end o patient up. If a radical cure has not been atte spica bandage to the groin, and later a truss. A a radical cure has been made.

Mortality.—Cases of strangulated hernia in tically all die without operation. The mortality it is not due to operation, but is due to the conditidelay in operating or to forcible antecedent tax



Fig. 674.—Double inguinal ruj

1429 herniotomies, estimates the mortality at 20. mortality according to the time of strangulation, I ing conclusions: The mortality of cases operate the strangulation is 8.09 per cent.; during the during the third day, 45.5 per cent.; during the ("Atlas and Epitome of Abdominal Hernias," by lated and edited by Wm. B. Coley, M.D.) I smaller than in adults. In Coley's 12 cases of chi there was not a death.

Hernia in Childhood.—Hernia is extremel it is an interesting fact that if one conducts a cain adults, it will be found that but 5 or 6 per with the hernia in childhood. This fact seem that the majority of cases of hernia in childhood. Ochsner ("Jour. Amer. Med. Assoc.," Dec. 22, 19

frequency of hernia in childhood, alludes to Malgaigne's statistics. Malgaigne estimated that during the first year of life one child in every twenty-one has hernia, and that this proportion is maintained until the age of six. Then it diminishes rapidly until the age of thirteen, at which age there is one hernia in every seventy-seven children. It is, therefore, obvious that 75 per cent. of all herniæ in children of six years will heal spontaneously before the age of thirteen. Ochsner states that 95 per cent. of herniæ in children will be cured without operation. He points out that between the ages of thirteen and twenty hernia is fairly common among boys, but very rare among girls. The reason for this tendency to cure is somewhat uncertain. The view advocated by Thomas C. Martin is that, as the pelvis broadens, the parietal peritoneum enlarges. It does this at the expense of the mesentery, which is shortened, and the internal abdominal ring is displaced. In a very instructive analysis of this condition Ochsner shows that in 25 per cent. of cases of hernia in childhood hereditary weakness exists; that the condition is commoner among the poorer classes than among the richer; that in many cases there is an undescended testicle; and that the chief cause is an excess of intra-abdominal pressure. This excess of intra-abdominal pressure may result from flatulent distention of the stomach and intestines, the product of bad feeding; constipation and straining; straining on urinating, due to the existence of phimosis; vomiting, or cough. He thinks that, as a rule, indigestion causes flatulence and pain; that the child cries; that this increases the pressure; that the mother then feeds it, in order to keep it quiet, and that this makes it worse. Strangulation is rare in childhood.

Treatment.—Strangulated herniæ, irreducible herniæ, herniæ with very large rings, cases in which trusses fail, and cases associated with reducible hydrocele require operation (Ochsner). Most cases are curable without operation, the ring being guarded by a truss of rubber or a pad of lamb's wool. Ochsner believes that many cases can be cured by keeping the child recumbent, with the foot of the bed raised, from four to six weeks. If phimosis exists, it should be operated upon, and any other causative condition should be treated (cough, vomiting, constipation, flatulent indigestion, etc.). An umbilical hernia can usually be cured by the use of a cork. The cork should be one inch in diameter and one and one-fourth inches in length, and shaped like a cone. The smaller end is pushed into the ring and the cork is held in place by adhesive plaster. In two weeks a smaller cork must be used, and in six or eight weeks it can usually be dispensed with. Radical cure operations are seldom done before the age of four (page 1127).

this he nal to the sar inguina transve infund transve lavers. pushes tendon superfi fascia, versali and pe In conten abdom selback the dee pass de emerge may or or labit The p The ne the dee erings

interco

muscle

Varieties of Hernia.—Direct inguinal hernia cent. of cases of inguinal hernia. In direct her through Hesselbach's triangle internal to the dee enter the inguinal canal low down, and pass outsit force the conjoined tendon before them or split t do not enter the scrotum. The neck of the sac i gastric artery. The protrusion is globular in shap the edge of the tendon, in which case it is pear s

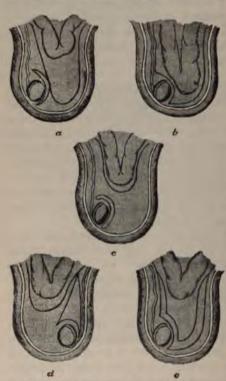


Fig. 675.—a, Scrotal hernia; b, congenital hernia; c, funicular hernia; d, infantile hernia; e, encysted hernia.

Congenital inguinal hernia is a portion of vaginal process. The bowel in congenital hernia in front of it. The testicle is posterior and below member that bowel may not enter the sac of a comonths after birth. Congenital hernia conceals or hernia does not. If a vaginal process, open above a hernia, the condition is called hernia into the fu

If the funicular process is closed at the abdom hernia in a special sac may descend back of the v tion is known as *infantile hernia*. In infantile he of peritoneum in front of the bowel—the two laye the one layer of sac. The testicle is in front (Fig If the tunica vaginalis is closed above and not below, and a hernia pushes down the vaginal process and causes it to double on itself, the condition is

known as encysted infantile hernia (Fig. 675, e),

In femoral hernia the contents descend along the femoral canal, and the neck of the sac is at the femoral ring. The neck of a femoral rupture is always external to the pubic spine; the neck of an inguinal rupture is always internal to the pubic spine. Femoral hernia contains omentum, but seldom intestine, except in strangulated cases. It used to be said that femoral hernia is never congenital. Russell and Coley show that it may be (page 1124). The coverings of a femoral hernia are skin, superficial fascia, cribriform fascia, crural sheath, septum crurale, subserous tissue, and peritoneum.

Umbilical hernia may be congenital (the ventral plates having closed incompletely), infantile (the cicatrix of the umbilicus having stretched), or

acquired.

Ventral hernia is a protrusion through any part of the anterior abdominal wall except at the umbilical or inguinal regions. A ventral hernia may be median (hernia of the linea alba) or lateral. The treatment is radical operation.

Epigastric hernia is a form of ventral hernia. In this condition there is protrusion of the peritoneum in the space bounded by the ensiform cartilage, the ribs, and the umbilicus. The sac of peritoneum may be empty, may contain omentum, or omentum and bowel. The stomach very rarely passes into the sac. The protrusion is usually, but not invariably, through the linea liba. The condition may be due to a congenital gap in the transversalis fascia or to the growth of a fat hernia.

Cecal hernia is very uncommon in women. It may be either congenital, infantile, or acquired. If a vaginal process is open the cecum may readily enter in, it may be drawn in by the plica vascularis as the testicle descends (Wrisberg), it may be drawn in by a descending testicle the posterior peritoneum over which has formed adhesions to the cecum. Most acquired cecal herniæ are preceded and caused by hernia of the small gut, but they may occur alone. In the simple form the cecum is completely covered by a coat of peritoneum and lies within the sac. Usually there is a complete surrounding sac, but sometimes the sac partially covers the cecum lying in front and to the inner side. In these cases the cecum is on the posterior and external aspect of the wall of the sac. The appendix may be in the sac, outside of the sac, or part may be within and part without. If the sac is incomplete, it means that we have one of the 18 per cent. of cases in which the cecum is not completely covered with peritoneum. A cecal hernia may be and usually is right inguinal, but may be right femoral, left inguinal, or left femoral. It is most common in advanced life and is frequently irreducible.

Hernia of the appendix may occur alone, and Merigot de Treigney collected 22 cases of it ("Thèse de Paris," 1887). In 17 the hernia was inguinal; in 5 it was femoral. I operated upon a case of appendicitis in which the inflamed appendix was the sole occupant of an incomplete right inguinal hernia sac.

In some cases the appendix accompanies the cecum into a hernia.

Sliding hernia of the ascending colon is due to the looseness of the peritoneum of the iliac region, which permits a portion of the large bowel to slide into a hernia. In such a case the posterolateral aspect of the sac is absent (Figs. 676 and 677). The descending bowel carries with it into the scrotum

a fold of loosened peritoneum, just as in the descent of the testis (see Weir, in "Med. Record," Feb. 24, 1900). Sliding hernia of the ascending colon is wrongly called sliding hernia of the cecum. Sliding hernia of the descending colon, wrongly called sliding hernia of the sigmoid, may occur. In most cases the descending colon is dragged into a preëxisting hernia sac containing small bowel, omentum, or both. The large bowel is covered with peritoneum except posteriorly, where the mesocolon is attached. This form is nearly always irreducible and occurs particularly in elderly men. In another group of cases



Fig. 676.—The large intestine behind the peritoneum (Weir).



Fig. 677.—The retroperitonnal large intestine in a cross-section of the hernia with its incomplete sac (Weir).

the large bowel makes a direct inguinal hernia and the sac is limited to the anterior surface of the protruded gut.

In properitoneal hernia the sac is between the peritoneum and transversalis fascia. The form of hernia is sometimes produced by making taxon an inguinal hernia, when the internal ring is small or is blocked by a undescended testicle. In properitoneal inguinal hernia, which is the mocommon form, there are two sacs detectable, one in the scrotum, the other parallel with Poupart's ligament, and as one sac is emptied, the other distends (Breiter, of Zürich).

In interstitial or interparietal inguinal hernia the hernia sac is between the transversalis muscle and fascia, or between the external and internal oblique muscles, or between the fibers of the internal oblique muscle, or between the external oblique muscle and the transversalis fascia, the internal oblique and transversalis muscles being pushed aside (Sultan's "Atlas of Abdomia mat Hernias").

In superficial inguinal hernia the sac is between the aponeurosis of the external oblique muscle and the superficial fascia. This variety of bearing is always congenital and the testicle is invariably misplaced.

Obturator hernia passes through the obturator membrane or the obturator canal, and is felt below the horizontal ramus of the pubes, internal to the femoral vessels. The obturator nerve is pressed upon and pain arises its trajectory.

Lumbar hernia is a very rare condition. It may be congenital, traumatic, or spontaneous, and may follow a lumbar abscess. Baracz collected 68 cases. It occurs through the triangle of Petit, or just below the twelfth rib through the superior lumbar triangle, or through a congenital defect in the aponeurosis of the latissimus dorsi muscle, or through a defect near the triangle of Petit (Dowd, in "Annals of Surgery," Feb., 1907). A lumbar hernia may be present at the edge of or through the quadratus lumborum muscles.

The triangle of Petit is bounded in front by the external oblique, behind by the latissimus dorsi, below by the iliac crest, and its floor is formed by the internal The superior oblique. lumbar triangle (of Grynfelt and Lesshaft) is bounded anteriorly by the external oblique, posteriorly by the iliocostal muscle, above by the serratus posticus inferior and the end of the twelfth rib, and below by the internal oblique. The latissimus dorsi overlies it.

Sciatic or gluteal hernia passes through the great sacrosciatic foramen, above or below the pyriformis muscle, or through the lesser sacrosciatic foramen.

Pudendal hernia protrudes into the lower part of the labium, the bowel having descended between the ischial ramus and the vagina.

Perineal hernia presents in the perineum,

between the rectum and the prostate gland or between the rectum and the vagina.

Internal, retroperitoneal, or intra-abdominal herniæ include hernia into the foramen of Winslow, hernia into the retroduodenal fossæ, the retrocecal fossæ, and the intersigmoid fossa.

Vaginal hernia is associated with uterine prolapse or ensues upon destruction of the vaginal wall.

Richter's hernia is the catching of a portion of the circumference of the

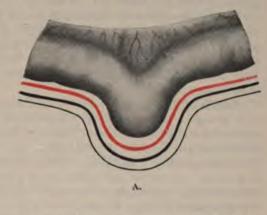




Fig. 678.—A. Diagrammatic representation of Richter's hernia of the intestinal wall. B. Diagrammatic representation of a hernia of Meckel's diverticulum (Sultan).

the side of the chest is unduly prominent. The upper border of the tympanitic area does not move with respiration. There are no breath sounds audible over the tympanitic area, but gurgling is heard. In 250 cases of traumatic diaphragmatic hernia collected by Leichtenstern the diagnosis was made before death in but 5 cases. The x-rays are of value in diagnosis, especially if the stomach is in the hernia. Strangulation of a diaphragmatic hernia produces severe pain in the upper abdomen, violent vomiting, constipation, boat-shaped abdomen, great thirst, rapid wasting, and the excretion of a very small amount of urea (Mackenzie and Battle, "Lancet," Dec. 7, 1901). Diaphragmatic bernia may be confused with eventration of the diaphragm, an unnaturally high position of the left half of the diaphragm, with ascent of the viscera of the abdomen, especially the stomach. It was first described by Petit in 1790. Sailer and Rhein reported a case and collected 12 others ("Am. Jour. Med. Sciences," April, 1905). The physical signs of eventration are practically identical with those of diaphragmatic hernia, except that in the former the upper border of the tympany moves on respiration.

Treatment.—Open the belly for exploration. If a hernia is found, return it to the abdomen; open the chest and suture the diaphragm from above (transpleural suturing). Mackenzie and Battle, Mikulicz, Humbert, and others have operated for this condition.

Hernia of the Ovary.—The ovary, because of failure of descent, may remain in the lumbar region. It may pass into the inguinal canal or labium majus (inguinal hernia); to the gluteal region (gluteal hernia); to the region of the obturator foramen (obturator hernia); or to the front of the abdomen (ventral hernia). In congenital inguinal hernia there may be ovary alone, or ovary, tube, omentum, and even part of a bicornate uterus (Garrigues). It is impossible to restore a congenital hernia. Acquired hernia may follow a fall and sometimes it can be restored. A femoral or crural ovarian hernia, a condition in which the ovary passes to the front of the thigh below Poupart's ligament, is never congenital. In some cases a herniated ovary can be returned within the abdomen. Any herniated ovary may inflame.

Treatment.—If it can be restored, a truss will probably retain it. If it cannot be restored or if it is painful or undesirable to wear a truss, operate. Expose the ovary, return it to the belly if healthy, and do a radical cure of the hernia. In some conditions of disease remove the ovary.

Hernia of the Uterus.—This condition is a surgical curiosity, but a few cases have been reported (see John Howard Jopson's case in "Annals of Surgery," July, 1904). The hernia may be umbilical, ventral, inguinal, or femoral. Hernia of the unimpregnated womb may be congenital or acquired; impregnation may occur when the uterus is herniated, or an impregnated uterus may pass into a preëxisting hernia sac. If a herniated uterus becomes impregnated or if an impregnated uterus becomes herniated, pregnancy may go on to term. Multiple pregnancies predispose to uterine hernia. Ovarian hernia may precede uterine hernia, or hernia of omentum adherent to the uterus may pull that organ into the sac. In many cases congenital anomalies have been found to exist (bicornate uterus, rudimentery uterus, shortness of the round ligament, imperforate vagina, etc.). A hernia of the uterus enlarges and becomes painful during menstruation, and a vaginal examination shows that the uterus is absent from its normal position and that the direction

Dermoids occasionally grow from the mucous membrane of the rectum and

are apt to contain an abundant growth of hair.

Examination of the Anus and Rectum.—There are four positions in which we may place the patient for rectal examination, the one to be selected depending upon the probable local difficulty. These positions are the left-lateral-prone, the knee-chest, the exaggerated lithotomy, and the squatting position. That most commonly employed is the left-lateral-prone position of Sims, in which the patient lies on the left side, the chest on the table, the left arm behind the back, the knees drawn up, and the pelvis elevated on a hard pillow. This position is used in the majority of cases for ocular, digital, or instrumental examinations.

Very stout people must be placed in the knee-chest position or exaggerated lithotomy position, as the rectum cannot be seen when they lie on the side.

A squatting position, when the patient is placed as though on a commode, is best adapted to cases of prolapse and hemorrhoids. It is also used to bring within the range of the finger strictures or new growths that in the other attitudes would be beyond digital reach.

In some patients one is able to pass a sigmoidoscope upon a patient in the xaggerated lithotomy position when it has been found impossible to carry the strument high enough with the patient in any other position.

While making a rectal examination the patient should have no constriction

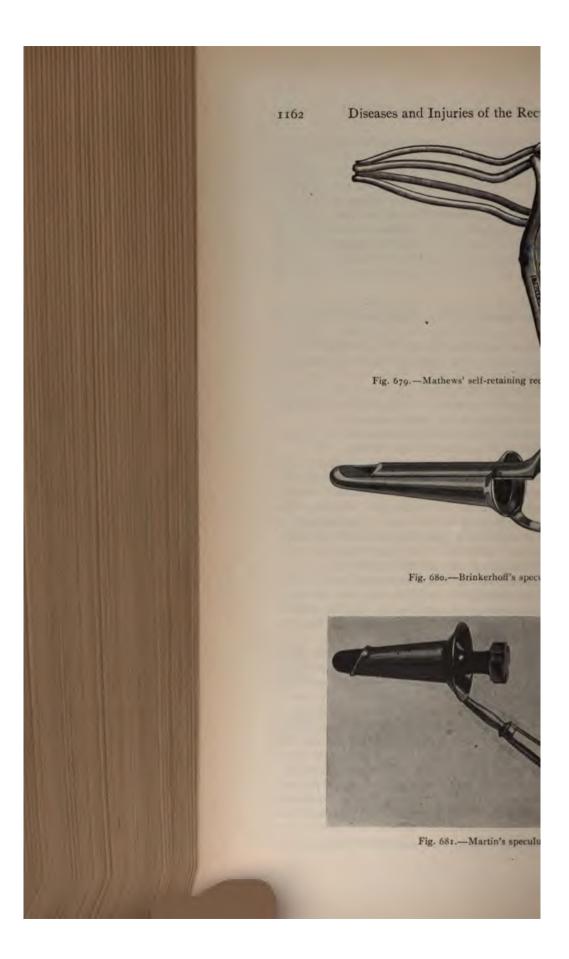
a bout the abdomen, such as dress, bandages, or any tight clothing.

It is important that the first examination be made when no cathartics or memata have been administered, so that the condition of the excretions and scretions may be noted. After these observations have been made an enema bould be given and the anus and rectum be well cleansed. By such first examination pus, blood, mucus, or inspissated fecal matter if present may be en, and from their varying characteristics, quantities and locations, causal inferences may be drawn. When the parts have been cleaned and the bowel washed out the anus is carefully inspected, the anal folds being opened during the process. By inspection the surgeon can notice the external opening of a firstula, external piles, protruding internal piles, mixed piles, pruritus, discharge from the rectum, eczema, fissure, tumor, ulcer, condylomata, abscess, whether or not the anus is retracted and funnel-shaped or protruding, or if there be parasites on the anal hairs.

Next the thumbs should be placed on either side of the anus and gently separated; this maneuver aided by a bearing down effort on the part of the patient will often cause piles to protrude, exhibit fissures and polypi, and reveal the condition of the mucocutaneous border.

Next, a digital examination of the rectum is made. The nail of the indexfinger is filled with soap and the finger is oiled or, better, is covered with a rubber finger-tip which is oiled. The digit is gently inserted through the sphincter, the patient being asked to strain lightly while it is passing. The finger is inserted with a gentle boring motion and is pointed toward the umbilicus until the sphincter is passed. A digital examination enables the surgeon to detect an ulcer, a polypus, a tumor, a stricture, and to determine certain points regarding the condition of the prostate in the male and the uterus in the female.

Next, in some cases the rectum must be examined with a speculum. It



ot often necessary to give ether. Mathews' speculum (Fig. 679) is very iceable. Sims' duck-bill speculum is a valuable instrument. The specuis warmed, oiled, and slowly introduced. It is first directed toward the



Fig. 682.—Cook's operating speculum.

pilicus, and when it passes the sphincter, its direction is gradually altered I it is toward the promontory of the sacrum. Illumination is obtained lirect sunlight, or by a forehead mirror and an electric light. This expansion will extend, confirm, or disprove the findings of the digital ex-

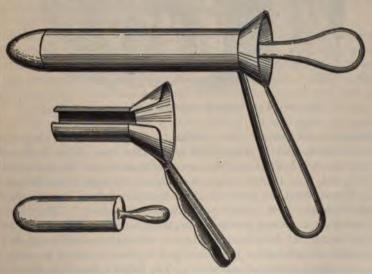


Fig. 683.-Kelly's rectal specula.

nation; ulcers, hemorrhoids, and malignant growths can be carefully mined, and the condition of the rectal mucous membrane can be thorthly investigated.

Marion Sims in 1845 demonstrated the ballooning of the vagina by atmos-

685). Dr. Tuttle describes it as follows ("Diseases of the Anus, Rectum, and Colon," by James P. Tuttle): "This instrument is composed of a large

cylinder (f), into one part of the circumference of which is fitted a small metallic tube closed by a flint-glass bulb at its distal end. The electric lamp (d) is fitted upon a long metallic stem, and carried through the small cylinder to the end of the instrument, as shown in the illustration. The proctoscope is introduced through the anus with the obturator (a) in position. As soon as the internal sphincter is passed, this obturator is withdrawn and the bayonet-fitting plug (b), which contains either a plain glass window or a lens focused to The length of the instrument to be used, is inserted in the proximal end of the

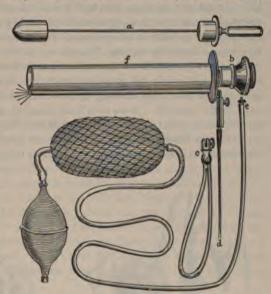


Fig. 685.—Tuttle's pneumatic proctoscope: a, Obturator; b, plug with glass window closing end of tube; c, handle; d, cords connecting instrument with battery; e, inflating apparatus; f, main tube of proctoscope.

instrument. This plug is ground to fit air-tight and thus closes the instrument perfectly. The plug being inserted in the tube, a very slight pressure upon the hand-bulb will cause inflation of the rectal ampulla to such an extent that the whole rectum can be observed and the instrument can be carried up to the promontory of the sacrum without coming in contact with the rectal wall. Further dilatation will show the direction of the canal leading into the sigmoid, and, by a little care in manipulating the instrument and keeping the gut well dilated in advance, it can be carried up into this portion of the intestine without the least traumatism of the parts. If any fecal matter obscures the light by being massed or smeared over the glass bulb, the plug can be removed, and a pledget of cotton, introduced with a long dressing forceps, will wipe this off so that the plug can be reintroduced and the examination continued with very slight delay or inconvenience. The adjustable handle (c) fits on the rim of the instrument and thus converts it into a Kelly tube. This instrument is operated with an ordinary dry battery of four cells. It is better, however, to have a battery with six cells, as it will not require being recharged so frequently." All the air must be allowed to escape before the instrument is withdrawn, otherwise colic may develop.

If an anesthetized patient is placed in the knee-chest position, the sphincter can be stretched by the fingers, and the rectum will distend with air and can be easily examined. The fingers are introduced as suggested by Martin (Fig. 686) and the rectum becomes visible when they are separated (Fig. 687).

lifted out. If the body is of wood, screw in a gimlet; if of metal, cut with strong forceps; if of glass, break into small pieces. If the article is rough or has sharp edges, pack gauze all around it as a first step to protect the rectal walls. In a case in which a boar's tail had been introduced, large end first, the holding back of the bristles was overcome by sliding over it a large-sized rubber catheter.

Foreign bodies may escape into the sigmoid and necessitate a laparotomy.

They may also cause periproctic inflammation.

A remarkable series of cases of foreign bodies in the rectum may be found in "Anomalies and Curiosities of Medicine," by George M. Gould and Wal-

ter L. Pyle.

Wounds and Injuries of the Rectum.—These accidents may result from fractures of the pelvis, most often from fractures of the sacrum, from the improper use of enema syringe nozzles or tips, from gunshot-wounds, stab wounds, from foreign bodies introduced by the patient, and, rarely, from digital examinations. The important points to consider in these wounds are whether or not there is penetration of the entire rectal wall, involvement of the perirectal tissues, or peritoneum. Slight wounds involving only the mucous membrane are frequently very grave from the fact that the hemorrhage is constant into the rectum, filling back into the sigmoid, often followed by collapse when the blood is voided. The investigations in these cases should always be thorough and by both digital and visual examination, for exact diagnosis is of the utmost importance.

If the peritoneum has been lacerated, laparotomy should be performed at once, the wound in the bowel repaired, the peritoneal cavity cleansed, and the Murphy treatment for general peritonitis instituted. If the laceration involves the perirectal tissues but not the peritoneum, cut down on the side of the bowel that is injured and make free drainage. In the event of very extensive injuries to the perirectal tissues the question of inguinal colostomy should be considered. If the wound involves only the mucous or submucous coats, dilate the sphincter, arrest hemorrhage by suture or ligature, and follow by irrigation.

Inflammation of the Rectum and Sigmoid (Proctitis and Sigmoiditis).—These conditions may be acute or chronic, simple or specific. The simple forms are acute catarrhal, atrophic catarrhal, and hypertrophic catarrhal. The specific forms are gonorrheal catarrhal, diphtheritic catarrhal, eresipelatous catarrhal, dysenteric catarrhal, and syphilitic catarrhal (Tuttle).

Acute Inflammation.—Acute catarrhal inflammation may be caused by that class of incidents followed by ordinary catarrh of the respiratory passages and, in addition, errors of diet or sudden change of temperature, as sitting on a cold seat when overheated. The onset is sudden, with chill, general malaise, pain and discomfort locally, and slight fever. There is a sense of fulness and weight, with often a burning sensation referred to the rectum, and at times tenesmus with frequent desire to go to stool. Pain radiates to adjacent parts and there is bladder irritability. Patients usually prefer to be in the recumbent posture.

There will be at first a thin fecal discharge followed by mucus tinged with blood. Ulceration soon supervenes. The parts are hot, dry, and swollen in the first stages and digital examination is very painful. Later the parts are slimy and the mucous membrane is covered with tenacious mucus and pus.

Treatment.—First remove irritating intestinal contents and reduce en-

gorgement by lavage and saline cathartics, followed, if early in the case, by irrigations of cold water; if later, by hot water. A useful medicated irrigation is a 5 to 10 per cent. solution of the aqueous extract of krameria.

Chronic Inflammation.—In chronic proctitis and sigmoiditis the symptoms are similar to those present in the acute forms of the inflammation, but less severe in character. In addition there is increased secretion of mucus, flatulence, and marked general intestinal disturbance.

The mucous membrane is soft, doughy, and thickened, which condition palpably reduces the caliber of the gut. Through the speculum the membrane is seen to be edematous, pale, and covered with secretion. It bulges into the

aperture of the speculum and does not bleed easily.

Treatment is hygienic and dietetic, with antiseptic and astringent irrigations. Atrophic Inflammation.—The atrophic variety of these inflammations is characterized by long-continued constipation, dry stools covered with blood and mucus. There is such pain on expulsion of feces as to simulate in many cases fissure of the anus. The mucous membrane of the anus ruptures easily when stretched during examination. It is bright red and shiny, does not fill the aperture of the speculum, and bleeds readily. Ulceration is common and hemorrhoids are a frequent complication. Treatment is local and general Locally use nitrate of silver, hydrastis, or ichthyol, applied after the rectum is emptied. General treatment is hygienic and dietetic.

Peri-anal and Perirectal Inflammations.—These are of two classes—circumscribed inflammations or abscesses and diffuse inflammations that always develop pus. The circumscribed variety may be either superficial or deep. The superficial variety again may be tegmentary, subtegmentary, or ischiorectal. The deep variety may be of two forms—retrorectal or superior pelvirectal. It is important to note that right-sided superior pelvirectal

abscess may be confounded with appendicitis.

The diffuse perirectal inflammations are variously classified, but the particular names refer only to the degree of the inflammatory process, which may

vary from ordinary suppuration to gangrene.

These inflammations travel in the line of least resistance, which is upward, and more often burst into the bowel than externally. They may follow chilling of the region or external traumatisms, may be caused by perforations of the rectum by hard fecal masses, or by the direct passage of bacteria into the fossa through a fissure, an ulcer, or an ulcerated pile. They may be either acute or tuberculous. In many cases the process is at first tuberculous, and secondary

infection with pyogenic bacteria takes place.

The symptoms are the same as those of abscess anywhere, the swelling, however, being brawny, and it being difficult or impossible to detect fluctuation. Pain in the groins is often complained of, and there may be enlarged glands in these regions. Abscesses commonly result in fistula, and a patient should be warned of this tendency before operation is performed. Superior pelvirectal abscesses generally follow inflammation of some pelvic organ, viz.: tubes, urethra, prostate, and the symptoms are mainly those of such an inflammatory condition. The usual tendency of the pus is to burrow upward. The presence of pus is indicated by the symptoms of suppurative toxemia, which sometimes simulate typhoid fever.

The treatment is instant incision. The patient is placed in the lithotomy

position after having been anesthetized. The cut should be parallel to the fibers of the external sphincter and well outside of the muscle and longer than the inflamed area. When this incision is made the finger should be introduced to break down the necrotic septa of cellular tissue. Then an incision should be made from the middle of the first cut radiating outward and opening any pockets external to the original focus. Then the free edges of the cuts are pared away, sacrificing all involved tissue. The wound is irrigated, the sphincter dilated, and the cavity packed with iodoform gauze. If a fistula is found opening into the rectum, it is not to be operated on until after the wound is nearly healed, only a small fistulous tract remaining.

In cases of superior pelvirectal abscess the incision should be made at right angles to the fibers of the levator ani muscle to facilitate drainage. In these cases tubal drainage is used.

Imperforate Anus.—There are two forms of this condition. In one form the rectum empties into the bladder, vagina, or urethra. In the other form there is no rectal opening either upon the surface of the body or in the urinary organs. The diagnosis is usually at once apparent, except in cases where the anus looks normal, when the diagnosis will often not be made until symptoms of obstruction arise.

Treatment.—If the rectum bulges when the child cries, open into it with a knife and keep the opening patent by inserting a plug of iodoform gauze. In cases in which the rectum is more deeply seated, a catheter is introduced into the bladder, an incision is made from the anus to the coccyx, the rectum is sought for, and when found, is sewed to the anus and is incised. In some



Fig. 688.-Fistula in ano: A, Blind external; B, blind internal; C, complete (Esmarch and Kowalzig).

cases Keen and others have performed Kraske's sacral resection, pulling down the rectum to the anal margin, sewing it there, and incising the occluded anus. If the rectum cannot be found or cannot be pulled down, an artificial anus must be made.

Fistula in ano is the track of an unhealed abscess. An abscess in the anal region is apt to refuse to heal because of the constant movement of the parts (produced by respiration, coughing, the passage of gas, defecation, etc.). The passage of feces will keep a fistula open. If a tuberculous ulcer perforates, a tuberculous sinus forms, and a tuberculous sinus is also apt to follow a cold abscess of the ischiorectal fossa. Fistula is often associated with phthisis pulmonalis, and is not unusually linked with piles, cancer, or stricture.

There are three varieties of fistula—the blind external (Fig. 688, A), the blind internal (Fig. 688, B), and the complete (Fig. 688, c). The external opening is usually near the anus, but may be far away, and there may be only one pathway or there may be several sinuses and openings. In a healthy individual the external orifice is small and a mass of granulations sprouts from it. In a tuberculous fistula the external orifice is large and irregular,

with thin and undermined edges, shows no granulations, extrudes small quantities of sanious pus, and the skin about it is purple and congested. In a fistula following an anal abscess the *internal* opening is just above the anus, between the two sphincters. In fistula following an ischiorectal abscess the internal opening is usually near the anus, but may in rare cases be above the internal sphincter. A sinus may run up under the mucous membrane from the internal opening. In a *horseshoe fistula* the internal opening is usually upon the posterior wall of the bowel, "and from this a tract leads into the ischiorectal fossa, not on one side only, but upon both. Therefore we have one opening into the bowel and one through the skin on either side."\* In some cases of horseshoe fistula there is no internal opening; in other cases there are two openings. In an old fistula the track becomes fibrous and cannot collapse. Two or more



Fig. 689.—Operation for fistula in ano (Esmarch and Kowalzie).

fistulæ may exist in the same patient. In dealing with a fistula always determine if the condition is stationary or progressive. The symptoms of a complete fistula are the passage of feces and gas through the opening and the flow of a discharge which stains the clothing. In a complete fistula a probe can be carried from the external opening into the bowel. After a time incontinence of feces is apt to come on, repeated attacks of inflammation thickening the rectum and destroying its sensibility. From time to time the opening will block, and new abscesses form. In examining a fistula use Brodie's probe, as its flat handle enables one to locate the direction the bent instrument has taken, and its slender shaft will find its way through a very small channel.

Treatment.-In treating a fistula cleanse the parts, as cleanly work, though it will not prevent pus, will limit suppuration. The external parts are washed with soap and water. The rectum, which must be empty, is irrigated with hot saline solution. Corrosive sublimate should not be used in the rectum, because it is irritant, causes a flow of serum, and hence lessens tissue resistance, and is rendered inert as an antiseptic by being converted into sulphid of mercury. Anesthetize the patient with ether unless the fistulais tuberculous, in which case use local anesthesia, spinal anesthesia, or nitrous oxid. Ether is avoided for fear of the existence of a pulmonary focus. A tuberculous focus in the lung may disseminate after inhalation anesthesis (page 1191). Place the patient in the lithotomy position. If operating upon a complete fistula, pass a grooved director into the external opening, carry it through the sinus, make it enter the bowel, bring its point out externally, and lift the tissue between the sinus and the surface. Incise the bridge of tissue (Fig. 689). If the director ascends above the internal opening, the opening must be made into the bowel from the summit of the sinus. Cut the sphincler at a right angle to its fibers, and do not cut it more than once at one operation. If a fistula is non-tuberculous, cut with a knife. If it is tuberculous, divide the tissues with a Paquelin cautery in order to lessen the danger of dissemination of the infection. Push the finger to the depth of the wound, to determine that the sinus does not ascend above the internal opening. Search with a small probe for branching sinuses, and if any are found, slit them open. Examine

<sup>\*&</sup>quot;Diseases of the Rectum, Anus, and Sigmoid Flexure," by Joseph M. Mathews

carefully to see if there is a sinus beneath the mucous membrane of the bowel, and if such a sinus is found, slit it up. Curet all sinuses, and if they are very fibrous, clip them away with scissors. Cut away diseased skin; irrigate with salt solution; pack firmly with iodoform gauze to prevent oozing; and dress with gauze and a T-bandage. The packing is removed in twenty-four hours unless it is soiled earlier, in which case it is promptly removed. After twenty-four hours the wound is irrigated and packed lightly with gauze to its full depth. This dressing should be repeated every day and any bridging of the tissues should be broken down with a probe. If the wound becomes sluggish it is stimulated with nitrate of silver and sodium iodid is given in small doses three times daily.

The bowels should be moved after forty-eight hours by enema. The diet should be light and fluid for the first few days after operation and the bowels should not be restrained by drugs. Get a tuberculous patient out of bed as soon as possible. If there are two fistulæ, cut one through, and when one wound has healed, cut the other. In some straight sinuses the tract can be extirpated and the parts sutured, primary union occasionally resulting.

If a blind external fistula does not heal, every sinus must be incised, and thickened walls must be cut away or scraped away.

In a blind internal fistula an external incision is made to convert the case into a complete fistula, which is then treated as is directed above.

In horseshoe fistula, more than one operation may be necessary in order to avoid cutting the sphincter muscle twice in one operation, a proceeding which would probably lead to fecal incontinence. One side alone is operated on at one séance. Sinuses are opened and scraped, the sphincter is divided, the angles and edges of skin are trimmed away, and the wound is packed. When the wound is healed, or nearly healed, the other side should be operated upon.

If fecal incontinence results from an operation for fistula, remove the scar tissue and endeavor to suture the separated muscular fibers. A modern scientific operation for incontinence is that of A. Mayo Robson ("The Practitioner," Feb., 1903). A crescentic incision, from ½ to ¾ inch in depth and taking in about one-half of the circumference of the bowel, is made at the anterior border of the anus. The middle borders of the incision are then pulled apart until the ends of the cut approximate in the middle line, when they are stitched with deep catgut sutures and the skin is sewed with silkworm gut, the immediate result being an incision apparently radiating from the anus. Should an operation be undertaken for fistula if phthisis exists? Many of the old masters said no. Mathews sums up the modern view: In incipient phthisis operate; in rapidly progressive fistula operate whether cough exists or not; if much cough exists, do not operate unless the fistula is rapidly progressive; in the last stages of phthisis do not operate.

Pruritus of the anus is a symptom, and not a disease. It may be due to piles, fissure, seat-worms, eczema, nerve-disturbance, kidney disease, gout, jaundice, constipation, inebriety, the opium-habit, torpid liver, dyspepsia, alcohol, tea-drinking, vesical calculus, tobacco-smoking, urethral stricture, uterine disease, diabetes, ovarian trouble, and mental disorder. In some cases it seems to be a pure neurosis and no special causative factor can be recognized. It is vastly more frequent in males than in females, and is espe-

cially common in fat men who sweat profusely. It is seldom seen before the age of thirty, except in children suffering from threadworms. The itching comes on gradually and usually intermittently, but grows progressively worse and worse until it becomes torturing. In many cases it is at first noticed only when warm in bed; in other cases it exists day and night. A violent exacerbation may be excited by worry, anxiety, overwork, dietary indiscretion, a sudden change of temperature, and many other things. The itching finally becomes an unbearable agony, sleep, except in snatches, is impossible, the appetite disappears, the strength fails, and the sufferer may become a nervous wreck. In some cases of pruritus the anal folds are edematous, there are abrasions here and there from scratching, the area is white and moist and gives origin to a fine secretion; in other cases the mucous membrane is dry and fissured.

Treatment.—In every case first of all make a careful examination to find a probable or a possible cause, local, reflex, or constitutional, and endeavor to remove this supposed cause. Then undertake treatment for the pruritus. It is very important to prevent constipation. Kelsev directs that the parts be cleansed twice a day, and after each cleansing that the following ointment be applied: menthol, 3i; cerat. simp., 3ij; oil of sweet almonds, f 3 j; acid. carbolic., 3 j; pulvis zinc. oxid., 3 ij. Mathews commends the following mixture: chloral, 3j; gum-camphor, 3ss; glycerin and water. each, 3 i.\* In this disease a "scarf skin" forms, which must be made to peel off by the application of iodin, pure carbolic acid, corrosive sublimate (gr. iv to 3j of cosmolin), calomel (3ij to 3j of cosmolin), or camphophenique. In obstinate cases paint the parts, night and morning, with a mixture of 60 gr. of alum, 30 gr. of calomel, and 300 gr. of glycerin; or smear with an ointment composed of 1 part of oleate of cocain, 3 parts of lanolin, 2 parts of vaselin, and 2 parts of olive oil (Morain). In very severe cases in which the skin is dry and cracked, apply a 5 per cent. solution of eucain to the abraded portions and paint the entire surface with a concentrated solution of silver nitrate. It may be necessary to repeat this treatment several times at intervals of four or five days. Adler advised us to apply to the parts the day after the silver has been used unguentum hydrargyri nitratis in full strength, only discontinuing on the day a fresh application of silver is made and the next day resuming the applications of ointment. If during treatment the skin becomes sore, use calomel ointment until soreness disappears. Violent attacks of itching are met by applying hot water and black wash or calomel ointment. This plan of treatment must be pursued for some months (Lewis H. Adler, Jr., "New York and Phil. Med. Jour.," July 29, 1905). I have used this plan with some satisfaction. In severe and protracted cases we may employ the x-rays twice a week (J. R. Pennington). I have seen their application productive of great benefit. In some cases we employ the Paquelin cautery, in others we resect the mucous membrane, as in Whitehead's operation for hemorrhoids. Ball divides the sensory nerves going to the implicated skin and has obtained excellent results.

Fissure of the anus is an irritable ulcer at the anal orifice producing spasm of the sphincter. Pain exists because twigs of nerves are exposed upon the floor of the ulcer. Fissure is caused by constipation or traumatism. The

<sup>\*&</sup>quot;Diseases of the Rectum."

symptom is violent, burning pain, sometimes beginning during defecation, but usually at the end of the act, and lasting for some hours. Constipation exists, and often pruritus. Examination discloses a fissure, usually at the posterior margin, running up the bowel one-quarter to one-half an inch. Piles often exist with fissure.

Treatment.—The palliative treatment is to prevent constipation, to wash out the rectum with cold water, and apply an ointment made by evaporating 5 ij of the juice of conium down to 3 ij, and adding it to 5 j of lanolin and gr. xij of persulphate of iron. Pure ichthyol frequently promotes healing unless the edges are thick or the base indurated, when operation must be done.

Operative Treatment.—Anesthetize the patient. Thoroughly cleanse the parts. Some surgeons advocate operation without stretching the sphincter. The fissure is incised through its base  $\frac{1}{4}$  inch deeper than the deepest part of the ulcer, extending  $\frac{1}{4}$  inch above and below the diseased tissues, so that the healthy muscular fibers at either end are divided. In cases in which the ulcer is at either the anterior or posterior commissure a V-shaped incision is made, the apex of which should begin  $\frac{1}{4}$  inch above the highest point of the ulcer and the diverging line running close to the sides of the fissure, but in healthy tissue.

If there are redundant edges, exuberant granulations, a sentinel pile, or a polypus, they should be curetted or excised. The wound is then packed lightly with gauze and the patient kept in bed for twenty-four hours. A large percentage of these operations may be done under local anesthesia.

Many cases are so sensitive and painful to the touch that medication and examination are almost impossible. These may be made bearable by insufflations of orthoform. It has always been my custom to stretch the sphincter for fissure. Stretching gives us room in which to work, and, by thus paralyzing the muscular fibers, the raw surface is put at rest and paroxysms of pain cease to occur. In order to stretch the sphincter the patient is anesthetized, the surgeon's thumbs are inserted into the rectum, and the parts are stretched until the thumbs touch the ischia. After stretching the sphincter incise the floor of the fissure, scrape it with a curet, search carefully with a probe to be sure no pockets exist, and touch it with nitrate of silver stick.

Hemorrhoids, or Piles.—There are three varieties of varicose tumors of the rectum, namely: *internal*, which take origin within the external sphincter; *external*, which take origin without the external sphincter; and *mixed* hemorrhoids, which are a combination of the two.

External hemorrhoids are covered with skin. Internal hemorrhoids are covered with mucous membrane. The term external hemorrhoids is not strictly accurate, as hemorrhage does not occur in external piles, and all external piles are not related to the external hemorrhoidal veins. An external pile may involve the veins or the skin.

External Hemorrhoids.—External hemorrhoids are classified as thrombotic, varicose, inflammatory, and connective-tissue external hemorrhoids (Tuttle).

Thrombotic External Hemorrhoids.—These are external hemorrhoidal veins filled with clot. When an external hemorrhoidal vein inflames, the parts become itchy, painful, and swollen, and defecation increases the pain. The blood clots in the inflamed vein and sometimes the vessel ruptures.

Symptoms and Treatment.- External piles of this variety are usually, but not always, multiple. Small oval tumors appear beneath the skin or the junction of the skin and mucous membrane. They appear suddenly. The parts itch and pain, defecation increases the pain, and each pile increases rapidly in size. When the vein ruptures, a livid, soft enlargement rapidly forms. External piles of this variety may be absorbed, may become organized into a scar, or may suppurate. These piles do not bleed. In treating external hemorrhoids some surgeons merely use remedies to combat the inflammation. An old plan of treatment is to incise the blood-tumor, turn out the clot, and pack with a bit of iodoform gauze. Mathews freezes the part or injects cocain, catches up the blood-tumor with a volsellum, excises the tumor and the tabs of inflamed skin, dusts the part with iodoform, and dresses it with antiseptic gauze. The bowels should not be allowed to move for two days. Never inject external piles with carbolic acid; it causes great inflammation, violent pain, and is not free from danger. If the patient declines operation, order rest, a non-stimulating diet, avoidance of tobacco (Mathews), the use of saline purgatives, injections into the rectum of cold water several times a day, sponging of the anus frequently with hot water. and the application of hot poultices. As the acute symptoms begin to disappear use lead-water and laudanum; when they have nearly subsided, apply zinc ointment. Extract of hamamelis is a valuable application to external piles.

Varicose External Hemorrhoids.—These are varicose external hemorrhoidal veins and are visible at the anal margin when the patient strains. They rarely produce pain or discomfort, and it is seldom that operation is necessary. The bowels should be moved daily, but not with violent purgatives, and after each movement cold should be applied to the anus, while the patient is recumbent. Tuttle advocates the use at night of an ointment containing 3 ij of suprarenal extract and 3 vj of lanolin. The ointment is spread on cotton-wool, which is applied to the anus and held in place by a T-bandage.

Inflammatory Piles.—By this term we mean edematous inflammation of the anal folds. The inflammation may be due to a traumatism, the presence of an ulcer or fissure, etc. There are burning, itching, and swelling of the anus, which are all greatly increased by defection. One or more pear-shaped swellings can be seen at the anal margin.

In some cases medical treatment produces cure. This treatment consists, during the first twenty-four hours, in the use of cold and of rest in bed. After this period heat should be employed. Tuttle applies gauze soaked in a 25 per cent. solution of boroglycerid and places a hot-water bag over this. He also recommends the following ointment to be applied two or three times a day:

R.	Morphinæ sulph.,		gr. v-x
	Ichthyol,		3 iv
	Ung. belladonnæ, 1	āā	Z:
	Ung. stramonii,		33.
Sig.	-Apply two or three	times a day.	

If these means fail, ether is given, the sphincter is stretched, and the tumors are cut away.

Connective-tissue External Hemorrhoids (Skin Tabs).—They are due to hypertrophy of mucocutaneous tissue at the anal margin. Usually

they result from acute inflammatory external piles; sometimes they arise gradually as a result of chronic anal or rectal inflammation or irritation, and they may be due to varicose or thrombotic external piles (Tuttle). They produce no trouble when not inflamed. The treatment, if they cause serious annoyance, is extirpation.

Internal hemorrhoids are varicose tumors of the internal hemorrhoidal plexus, and are found internal to the external sphincter, just within the anus, and they prolapse easily. They are not simply varicosities, but new tissue has been formed, and they are in reality vascular tumors. They are covered with mucous membrane. Capillary piles are small, sessile, with a surface like a mulberry, and bleed freely. Children are not very liable to develop piles, excepting the capillary form. Venous piles are the most common variety. They extend from just above the anal margin of the rectum for an inch or more. They are purple in color, soft, irregular in outline, and are usually multiple. They bleed when irritated by hard fecal masses, but not so easily as the capillary piles. Each pile is composed of a varicose vein, some fibrous tissue, and a few arterial twigs. Arterial piles are very unusual. They are large, smooth, pedunculated, bleed easily and freely, and contain, besides a distended vein, arteries of some size.

Anything producing venous congestion in the rectum—constipation, diseases of the rectum, enlargement of the prostate, pregnancy, tumors of the womb, congestion of the liver, cirrhosis of the liver, certain diseases of the heart and lungs, sedentary occupations, relaxing climate, and stricture of the urethra—will cause hemorrhoids.

Symptoms and Treatment.—If there is neither bleeding nor protrusion, the piles give no trouble. The first symptom is usually hemorrhage, and rectal examination by the speculum will make clear the condition. After a time, during defecation, the piles protrude; they may reduce themselves when the patient stands up, or it may be necessary to push them in. Pain does not exist in uncomplicated cases, and pain during or after protrusion means "abrasion, fissure, or ulceration" (Mathews).

Palliative Treatment.—This will not cure, but it will give great comfort. Some people only suffer at rare times when the liver is congested, and such subjects will not submit to operation. Remove, if possible, the cause (alcohol, irritating foods, want of exercise, etc.); restrict the diet; insist on regular exercise; give a course of Carlsbad salt, and follow this by the administration of bichlorid of mercury (gr. 1/24 after each meal). Prevent constipation by a nightly dose of extract of cascara. After each bowel movement wash the parts with a soft sponge soaked in cold water and syringe out the rectum with cold water, and dry outwardly with a soft rag. If the hemorrhoids prolapse, after restoring them and injecting cold water, insert a suppository containing gr. v of the extract of hamamelis, and use another suppository at bedtime. A useful suppository for prolapse is that employed by Tuttle: it contains gr. v of ichthyol, gr. v of tannic acid, gr. 1/3 of ext. of stramonium, gr. 1/3 of ext. of belladonna, and gr. x of ext. of hamamelis. Bleeding may be arrested by suppositories, each containing gr. v of suprarenal extract. When the piles prolapse and inflame, rub Allingham's ointment on the parts (3ij each of ext. of conium and ext. of hyoscyamus, 3j of ext. of belladonna, and 3j of cosmolin). Mathews uses gr. xij of cocain, 3j of iodoform, 3ss of ext.

of opium, and \$\frac{3}{2}\$ of cosmolin. Grant uses an ointment containing gr. viij of morphin, gr. xij of calomel, and \$\frac{3}{2}\$ iof vaselin. This is applied after bathing the part with hot water. If the piles are protruding and reduction cannot be effected, put the patient to bed, give a hypodermatic injection of morphin, and apply hot poultices. If reduction cannot soon be effected, divulsion of the

sphincter must be practised or radical operation must be resorted to.

Operative Treatment.—Give a saline the morning before, and an enema the evening before, the operation, and wash out the rectum well the morning of the operation. In treating by injection of carbolic acid the sphincter should be divulsed while the patient is under the influence of nitrous oxid gas unless the pile is thrombotic. "Under gas muscular relaxation does not obtain as in the use of ether. Hence dilatation under gas can be more rapidly induced, as we have the sphincteric rigidity as a guide in knowing exactly how much force may be employed in the individual case" (Lewis H. Adler, Jr., in "Jour. Am. Med. Assoc.," Jan. 21, 1905). The surgeon must be careful not to tear the parts. The tumors are drawn out or, if gas was not given, the patient strains them out.



Fig. 690.-Brick's pile clamp.

an injection is given by a hypodermatic syringe into the center of the pile, and as each pile is injected it is pushed into the rectum. But one or two piles are injected at each séance, and the operation is not repeated for one week (Geo. W. Gay, in "Boston Med. and Surg. Jour.," Dec. 5, 1901). The dose for each pile is mjor mij of a 10 per cent. solution of pure carbolic acid. The injections relieve the condition, but are rarely absolutely curative, and are not without danger, and may produce, it has been said, hemorrhage, phlebitis, pvemia, stricture, and even death (W. T. Bull). Dr. Collier F. Martin ("American Medicine," August 27, 1904) maintains that the method is safe and satisfactory. He injects equal parts of phenol boboeuf and distilled water, freshly mixed and filtered. From 7 to 15 minims are injected into a pile, and only one pile is injected at a séance. In from five days to one week another injection may be given. Before beginning a course of injections the sphincter is stretched while the patient is under nitrous oxid and oxygen. It is not necessary to repeat this for future injections. During injection a special speculum is used. The pile protrudes into the speculum, is cleansed with a r per centsolution of creolin and the injection is thrown into the most prominent part of the pile. The speculum is withdrawn before pulling out the needle. This maneuver prevents escape of injection and bleeding. The clamp and cautery is, in the great majority of cases, the operation of choice. It requires but a few minutes to do it; after it is done there is little or no postoperative pain, in

very many cases retention of urine does not occur, and the patient usually is about again within ten days. The patient is anesthetized and the sphincter is carefully and thoroughly stretched. The stretching of the sphincter is very important. It gives free access to the parts, prevents subsequent spasm and pain, and lessens the likelihood of venous bleeding after operation. The pile is caught with forceps and drawn outside of the sphincter. Many use Smith's clamp. It is applied with the ivory surface against the mucous membrane of the bowel. I use the clamp devised by Dr. J. Coles Brick (Fig. 690). From the bite of Brick's clamp the pile cannot slip as the blades come evenly and firmly



Fig. 691.—Extirpation of hemorrhoids (Esmarch and Kowalzig).

together. The pile is cut off, and the stump is seared with the Paquelin cautery at a dull-red heat. Pile after pile may be thus treated, care being taken to leave some mucous membrane at each side of every pile. If this precaution is not taken, healing will be slow and stricture will result. After cauterization is complete a speculum is inserted and the blades are

widely opened. Any bleeding point is at once ligated. Packing is never inserted. I formerly used it but have given it up. It is of no service and produces severe pain and edema. The treatment from this point is identical with that advised below after the use of the ligature. Excision is preferred by Allingham. He stretches the sphincter, holds it open with a retractor,

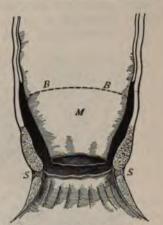


Fig. 692.—S, S, The lower circular incision along Hilton's white line; M, Tube of mucous membrane dissected from the sphincter; B, B, dotted line showing the place for the upper circular incision (Edmund Andrews).

catches up the pile, cuts it off, and twists the bleeding vessels. Some prefer to pass a silk or catgut suture, cut off the tumor, and tie the thread (Fig. 691). Whitehead's operation (Fig. 692) is only to be performed in severe cases, when the piles are extremely large and form a protruding circular mass. Primary union is rarely secured. When first introduced, the operation was viewed with favor, but experience shows it is sometimes followed by disastrous consequences.\* Stricture not infrequently arises after its performance; fecal incontinence occasionally results, and anal anesthesia with inability to restrain the passage of gas is common. After this operation the anus is permanently more or less moist. The entire pile-bearing area of mucous membrane is dissected out, and the cut margin of mucous membrane is pulled down and stitched to the surface. The sphincter may be dilated as a preliminary measure.

The application of the ligature is an easy and useful method. It is not so rapid as the cautery, is followed by more pain, healing requires a longer time, and stricture is more common. In this operation, after anesthetizing, stretch the sphincter and treat each hemorrhoid separately. Catch a pile

<sup>\*</sup> Andrews, in Mathews' Medical Quarterly, Oct., 1895.

with a pair of forceps or a volsellum, pull it down, and cut a gutter through the skin-margin if the pile is of the mixed variety; tie the small piles without transfixing, but transfix the large piles; tie with silk (coarse silk for the large piles, finer silk for the small piles); cut off each tumor beyond the thread, and cut the ligatures short. Treat the other piles in the same manner. Irrigate with hot normal salt solution. Do not insert packing. Apply a gauze pad and a **T**-bandage. Give some morphin to lock up the bowels, and keep the patient on a light diet for three days, at the end of which time a saline may be given. Just before the bowels act remove the dressings and give an enema of warm water or of glycerin. After the movement wash out the rectum first with dilute peroxid of hydrogen and next with hot salt solution, dust with iodoform, and apply a gauze pad over the anus. Irrigate daily



Fig. 693.-Rectal prolapse.

until healing is complete. After the tenth day examine with a speculum to see that the ligatures have come away; if any are found in place, remove them.

Prolapse of Anus and Rectum.—If the mucous membrane is prolapsed, the condition is called "prolapsus ani"; if the entire thickness of the rectal wall is prolapsed, it is called "prolapsus recti" (Fig. 693). The commonest form is due to relaxation of the submucous connective tissue permitting the protrusion of a ring of mucous membrane. Prolapse is apt to occur from excessive straining at stool and is commonest in feeble, ill-nourished children. A polypus may be causative. Piles and worms may lead to prolapse. Straining from phimosis, stone in the bladder, or urethral stricture may be causative. Its development is favored by the use of articles of food which cause frequent movements of the bowels. If an individual sits a long time on the seat of the closet or on the chamber the development of prolapse

is favored. Prolapse may be either large or small, but tends to recur again and again, and eventually the mucous membrane inflames, ulcerates, or sloughs. Strangulation of the prolapsed part may occur. The condition is sometimes confused with hemorrhoids, but in prolapse the protruding mass is circular and has a depression in the center (Fig. 693), whereas hemorrhoids are distinct masses. Further, hemorrhoids are very rare in children.

Treatment.—Palliative treatment forbids straining at stool and amends an improper diet. Phimosis must be corrected; stone in the bladder must

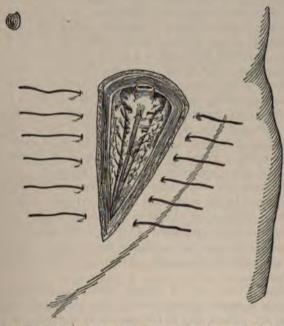


Fig. 694.—Joseph D. Bryant's method of colopexy; A, A, Longitudinal band, with sutures passed behind it, including peritoneal and muscular coats of the intestines, drawn forward; B, B, parietal peritoneum quilted to sides of the intestine, showing stitches; C, old fecal fistula.

be crushed or removed. If prolapse occurs, the protrusion must be bathed with cold water and restored. Constipation must be prevented (enemata of water or glycerin may be used), and after each movement several ounces of a solution of white oak bark should be injected. If a prolapse is caught firmly, place the patient in the knee-chest position, wash the mass with cold water, grease it with cosmolin, insert a finger into the rectum, and apply taxis around the finger (Mathews). If this fails, cover a finger with a handker-chief and insert the wrapped digit into the rectum; if this proves futile, invert the patient. Severe cases require ether before reduction is attempted. After reduction apply a compress, direct it to be worn except when at stool, and before each act of defecation give an injection of cold water containing an astringent (tannin or fluid ext. hydrastis). A useful treatment in many cases is to paint the prolapse with fuming nitric acid, grease it with olive oil, and restore it. Some cases require excision of the mucous membrane, the divided edge of this membrane being stitched to the skin. In other cases the

protrusion is stroked with a cautery and restored operate for recurring prolapse, it will often be a drawn and he may be obliged to stretch the sp. In persistent cases of rectal prolapse open the a to the belly-wall (colopexy or sigmoidopexy, Fig. mass (Cunningham, in "Annals of Surgery," Manals of Surgery," Manals of Surgery,

Ulcer of the Rectum.—Ulcers of the rectu traumatic, the syphilitic, the tuberculous, the and the malignant. Simple ulceration is due t or a foreign body, the abraded area ulcerating. for piles and also protracted labor (Allingham), base and edges of a simple ulcer are neither pror rarely forms. Syphilitic ulceration is a tertiary There are numerous small ulcers of the muco but little indurated, with sharp-cut edges which ulcers fuse and constitute one large irregular the wall of the bowel, induration becomes noti There is profuse discharge, and fistulæ are ap be surrounded by nodules of a bluish color. dition is stricture due to the formation of ma rectal walls, and ulceration occurs secondarily may be a breaking down of a huge gummy m It has been proved by the microscope that tubin the rectum. Tuberculous ulceration present hanging edges and a pale-red base. There is s tenesmus, and a little pain, but a stricture rarel diabetes, Bright's disease, neoplasms, and foreig tion of the rectum.

Symptoms.—There may be merely uneas sometimes there is severe burning pain on defet time after the act. There may be constipation of at stool, and the stools may contain blood, mucu diarrhea on rising in the morning, the first move mucus, and the next movement being fecal. The inquired into; tuberculosis should be sought should be investigated. A digital examination en ulcer, and an examination with an ordinary speculorings it into view.

Treatment.—In simple ulcer empty the boa saline cathartic, wash out the rectum with hacted, introduce a speculum, touch the ulcer winitrate (gr. xl to 3j), place the patient in bed, and every day inject iodoform and olive oil or rectum. If this fails, give ether, stretch the sphiits entire thickness, and cauterize with fumin case subsequently as we would a patient who tuberculous ulcer improve the general health, climate, or at least into the sunlight and fregive nutritious food, especially fats, wash out

hot water, and insufflate iodoform or inject iodoform emulsion. Touch the ulcer once a week with silver nitrate (gr. x to 3j). In *syphilitic* ulcer give antisyphilitic treatment and treat the ulcer locally as is done in tuberculous ulcer. *Dysenteric* ulcer requires injections of hot water, the touching of the ulcer with pure carbolic acid, insufflations of iodoform, and special treatment of

the dysentery.

Benign Tumors of the Rectum and Anus.—These tumors may be of the connective, epithelial, or muscular tissue type. Of the first there are fibroma, enchondroma, lymphadenoma, lipoma, and myxoma; of the second, adenoma and papilloma; of the third, myoma and fibromyoma. These tumors usually appear in polypoid form. A polypus is a tumor with a pedicle. The most common forms of tumor are the myxoma, hypertrophied solitary follicles, adenoma, fibroma, and lipoma. Myxoma is most common in children. Fibroma originates in the connective tissue or the submucosa and is very rare.

Symptoms of tumor are dull aching pain, tenesmus, frequent defecation, and sometimes ulceration of the mucous membrane. The absence of hemor-

rhages and mucous discharges distinguish fibroma from polypus.

Treatment.—Remove the tumor after dilating the sphincter. In tying or snaring off polypi it should be borne in mind that the peritoneum may be invaginated in the pedicle and, therefore, no traction on it should be made when operating. Sessile growths are dissected out. The postoperative treatment is

practically the same as for hemorrhoids.

Cryptitis (Inflammation of the Crypts of Morgagni).—These crypts, five to ten in number, are situated in the mucous membrane of the rectum about 3 centimeters from the anus. They occasionally become packed with mucus or feces. There is quite severe pain referred to the site, especially after defecation. In this condition the examination of the anus by the finger is extremely painful. The inflamed crypts may be detected by examination with the speculum.

Treatment.-Divide the affected crypts, curet away any granulations, and

allow the parts to heal.

Non-cancerous stricture of the rectum may be congenital or acquired. There are two forms of acquired stricture: first, stricture due to external pressure; second, stricture due to primary narrowing of the rectal wall.\* Stricture due to external pressure is very rarely complete, and may be caused by bands of adhesions or a cancerous growth. The second form may be produced by syphilitic tissue, ordinary inflammatory tissue, cicatrices after operations, sloughing, tuberculous, syphilitic, or dysenteric ulceration, rectal gonorrhea, and traumatism. The usual seat of simple stricture is from one inch to one and a half inches above the anus. The deposit may be limited to the submucous coat or all the coats may be involved. It is very seldom that stricture arises as a result of abrasion from fecal masses or foreign bodies. It may follow an operation for piles if considerable tissue is removed, and is an occasional sequence of Whitehead's operation. Stricture due to dysentery is extremely rare, and no case has ever been reported to the United States Pension Office (Peterson). The existence of stricture as a result of rectal gonorrhea has not been positively proved. A majority of sufferers from rectal stricture have labored under syphilis, but it is not

<sup>\*</sup> Reuben Peterson, in Jour. Amer. Med. Assoc., Feb. 3, 1900.

probable that the lesion is syphilitic in all or of stricture may be due to the formation of fibrous or may not occur. It may be caused by the colarge ulcer. Some maintain that tuberculous strates dissents from this view and points out that the matter is to break down, and before the rectume culosis it breaks down from ulceration. Peters of the victims of rectal stricture die of phthisis so-called syphilitic cases are tuberculous. It is an infiltration of submucous tissue. Although a culous lesion may cause rectal stricture, in mo expose the tissues to infection, and a benign reinfection. Hence tuberculosis causes stricture, than directly.

The symptoms of rectal stricture are consistraining at stool, the presence of blood and manus, and the passage of stools flattened out into down. In some cases there is fluid diarrhea, soli above the stricture. The stricture is found by the bougie, used with the utmost gentleness and car rough use of any instrument would be dangerous a In syphilitic cases, in tuberculous cases, and in beening is usually in the submucous coat, and in sypthe mucous membrane is apt to ulcerate. It is somay arise. I have seen obstructive symptoms, but nectal stricture. Distention of the abdomen a

The treatment of non-cancerous stricture i warm-water injections, mild laxatives, and hot tories may be needed. Any existing disease is t every other day. Use a soft-rubber bougie, warn it gently. If only the method of gradual dilatat must for the remainder of his life pass a bou fibrous strictures forcible dilatation (divulsion) employed or incision is practised. Incision external or internal. In internal proctotomy one from the rectum through the stricture down to bea in the middle line posteriorly. External proctotor ters, is apt to leave incontinence as a legacy. Electut on what grounds it is difficult to see. In som removed. In incurable cases perform inguinal or

Cancer of the rectum is the cancer of the It may be primarily malignant or may arise fro monest growths are composed of cylindrical cells, a In cases secondary to epithelioma of the anus or

In most rectal carcinomata the cells present a rounded by a more or less plentiful stroma of tumors the connective tissue is scanty; in hard t

Cancer is most common after the age of forty, but the thirty-fifth year, and is sometimes seen even a

<sup>\*</sup> Reuben Peterson, in Jour. Amer. Med. A

year. Extensive ulceration occurs. If a hard ring encircles the rectum, the lumen of the tube is greatly and progressively diminished. In cases of diffuse infiltration the lumen is not greatly lessened. In growths of the anus the inguinal glands are involved and also the glands in the hollow of the sacrum. In growths of the rectum proper the glands back of the peritoneum in the sacral hollow are involved, and the inguinal glands are involved late or not at all.

Symptoms.—The symptoms of rectal cancer are like those of nonmalignant stricture, except that the pain is usually greater, the hemorrhage more severe, and constipation is apt to alternate with diarrhea. The diarrhea is usually in the morning. Unfortunately, in many cases symptoms are long trivial; in fact, pain may be absent until the disease is far advanced. Mucopurulent or bloody stools are often thought to result from dysentery or hemorrhoids, which latter condition, however, may be only an accompanying condition of rectal cancer. Or the above symptoms may, on the patient's say-so, have been accepted by the physician as caused by hemorrhoids, without any local examination. The patient again may have only imagined the presence of hemorrhoids, since, according to his notion, the above symptoms must result from hemorrhoids, with which condition so many of his friends with like complaints are afflicted. Loss of strength, emaciation, and cachexia are generally noticeable only in the late stages of rectal cancer. Only in the very latest stages the characteristic odor is perceptible, the patient becomes septic, and abscesses attended by gangrene may form (Ernest Jonas, in "Interstate Med. Jour.," No. 4, 1906). The finger and the speculum make the diagnosis. In rectal cancer metastasis occurs late. The most favorable cases for operation are those in which the growth is small and movable. Accurately define the extent of the growth, and endeavor to make out if it has invaded the cellular tissue outside of the rectum, the prostate, the bladder, the sacrum, the uterus, etc.

Treatment.—In every case of cancer of the rectum the following question must be considered: Shall we perform a radical operation in hope of producing cure or at least greatly prolonging life? In what cases should a radical operation be attempted? It is the proper procedure if there are no metastatic deposits, if the patient is in fair general condition and free from serious organic disease, and if the cancerous bowel is movable and not fixed by dissemination to adjacent structures. As W. Watson Cheyne says ("Brit. Med. Jour.," June 13, 1903), a slight adhesion to the vagina is not a contraindication because this portion of the vagina can be readily removed with the diseased rectum. Some surgeons will not attempt radical operation if they cannot pass a finger through the growth. I do not regard high position as forbidding operation, although, of course, it makes it more dangerous to life and less promising as to cure. Cheyne is of the same opinion. When the surgeon is first called to a case of cancer of the rectum it is usually found to be so far advanced as to be inoperable. In at least 75 per cent. of my cases radical extirpation was impossible when I first saw the case.

If a radical operation is determined on, the next question to answer is, Shall we, or shall we not, do a *preliminary colostomy?* If the cancer is very low down and is to be removed from the perineum, preliminary colostomy should not be done. If the cancer is high up and we propose to attack it by Weir's method, or the Quenu-Mayo method, preliminary colostomy should not be done. If Kraske's operation is to be performed, I believe preliminary colostomy is indicated. It enables us to cleanse the area upon

which operation is to be performed, and to keep the wound clean, and gives us a much better chance of obtaining primary union. In cases in which the sphincter is retained and it is possible to anastomose the divided ends of the rectum together, colostomy is not necessary; and if an artificial anus has been made in such a case, another operation will be required to close it. As a matter of fact, I have found it always difficult and usually impossible to suture the divided ends of the gut together after Kraske's operation, and I now follow the advice of Keen, and always precede it by a colostomy. If radical operation is rejected (and about three-fourths of the cases, when first seen by the surgeon, are beyond

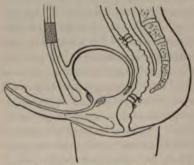


Fig. 695.—Tying off the tumor through an abdominal incision after separating peritoneum from sacrum and bladder (Weir).



Fig. 696.—Lower end of rectum everted through the anus and the upper end of bowel drawn out of the abdominal cavity (Weir).

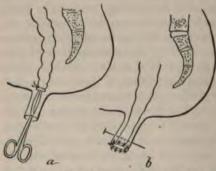


Fig. 697.—a, The upper bowel drawn out through the everted lower end of rectum; b, the ends of the two portions of the rectum sewn together (Weir).

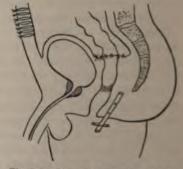


Fig. 698.—The united bowel replaced with posterior drainage and the divided peritoneum so sewn together as to shut off the general peritoneal cavity from the pelvis (Weir).

such aid), palliative treatment is desirable. One plan is to introduce a tube through the stricture daily, wash out the rectum with warm water, and after washing inject emulsion of iodoform (gr. x to 3j of sweet oil). Injections of chlorid of zinc (gr. j to 3j of water) lessen the foulness of the discharge. The bowels are opened regularly by laxatives, and if the growth causes obstructive symptoms, it is scraped away with a sharp spoon. Opium is given to relieve pain. The advantage of this plan is that the patient does not suffer from the unpleasantness of an artificial anus. Sooner or later, how-

ever, the growth gets outside of the bowel, and terrible pain will arise from involvement of the sacral plexus. W. Watson-Cheyne ("Brit. Med. Jour.," June 13, 1903) would restrict palliative treatment of this character to cases in which fungating masses grow from one side of the bowel.

If a growth encircles the bowel and produces symptoms of obstruction, palliative colostomy should be performed. This operation gives great comfort to the patient, and allays pain by intercepting the feces before they reach the cancer. I am not convinced that it distinctly retards the growth of the cancer or notably prolongs life. Unfortunately, colostomy does not do away with pain if the sacral plexus is involved. I have had no experience with radium in inoperable cancer of the rectum and have never seen the x-rays produce any marked or lasting improvement. Operative treatment includes one of several procedures. Excision of the rectum from below (Cripps's operation) is practised if not more than three inches require removal, if the peritoneum is not invaded, and if the adjacent organs are free from disease. The peritoneum must not be opened in Cripps's operation. After the growth is removed the divided rectum is pulled down and sutured to the skin. Excision of the rectum after excising the coccyx and a portion of the sacrum (Kraske's operation, Fig. 600) is a procedure which permits removal of the entire tube, portions of the colon, and even of adjacent parts. The peritoneum is opened deliberately in this operation, and is subsequently closed with sutures before the gut is opened. The glands from the mesocolon are always removed. The lower end of the upper segment of bowel is fastened in the wound, or, if colostomy has been previously performed, may be closed. In some few cases in which it is not necessary to remove the lower end of the rectum, the two portions may be anastomosed after resection of a part of the tube. Kraske's operation may be done by an osteoplastic method, the bone not being removed. It is well to precede a Kraske operation

two weeks by an inguinal colostomy, which permits of cleansing the lower bowel of feces and lessens the chance of severe wound-infection and delayed healing after the removal of the rectum. A preliminary colostomy may make the operation of extirpation more difficult by fixing the intestine, and thus interfering with the necessary drawing down of the gut (E. H. Taylor). If the growth is extensive and the mesocolon short, it may be best to perform

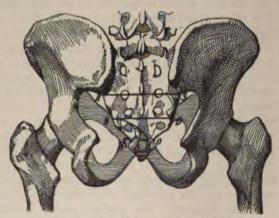


Fig. 699.—Different levels of resection of the sacrum: K O, Kocher's line; B, O, Kraske's; B, H, Hochenegg's; B, D, Bardenheuer's; R, S, Rose's (Mass.).

a right inguinal colostomy; but in most cases left inguinal colostomy is preferred (Gerster). The colostomy remains open during the patient's life, except in those rare cases of Kraske's operation in rectum can be reëstablished after excision of the artificial anus may be closed some time after the

Robt. F. Weir ("Med. News," July 27, 1901) with the difficulties and dangers of Kraske's o carcinoma that he now employs it solely in case from disease for two inches immediately above cancer does not extend more than five inches cases he does the following operation: Open the separate the peritoneum so that the bowel and " are liberated behind nearly "to the tip of the coc of the prostate." The tumor is then tied off v portion of the rectum bearing the tumor is rem bowel is everted through the anus, and the upp abdominal incision, Fig. 696). The upper end and drawn through the everted lower end of the ends of the two everted portions (Fig. 697, b) are bowel is replaced, the divided peritoneum is sutur cavity, and posterior drainage is inserted (Fig. operation the object is to remove all of the diseased (W. J. Mayo in "St. Paul Med. Jour.," April, 1906 of American Proctologic Soc., June, 1906.) The aggerated Trendelenburg position and the belly is The growth is studied to see if it is removable, and glands which might cause us, and for secondary gr to abandon the operation. If we conclude to attathe intestine except the sigmoid, catch two clamp them being on the level of the sacral promontory. Free the mesosigmoid by lateral cuts and bring th belly, ligate it, and apply a purse-string suture to in then made on the left side and the proximal stum sutured there. Incisions are now made in the side rectum, the inferior mesenteric artery is tied above ontory, the fat and glands are thoroughly remo vessels being tied as cut, except the middle sacra vessels, which are tied before division. The are and the patient is put in the lithotomy position with gauze, the anus is sutured, and the rectum is and urethra or from the vagina from below upwa ani muscle. An assistant presses the fragment ca abdomen and the surgeon removes it from the pe sutured within the abdomen, room being left for a from the perineum. The perineal wound is n wound in the belly is closed. In twenty-four hou sigmoid is opened and an artificial anus is thus m

The mortality of Kraske's operation is from eight per cent. of Kocher's cases of extirpation of well from three to sixteen years after operation Jour.," June 13, 1903).

## XXIX. ANESTHESIA AND ANESTHETICS.

Anesthesia is a condition of insensibility or loss of feeling artificially produced. An anesthetic is an agent which produces insensibility or loss of feeling. Anesthetics are divided into—(1) general anesthetics, as amylene, chloroform, chlorid of ethyl, ether, bromid of ethyl, nitrous oxid, and bichlorid of methylene; (2) local anesthetics, as alcohol, bisulphid of carbon, carbolic acid, ether spray, cocain, eucain, stovain, ice and salt, rhigolene spray, and ethyl chlorid spray.

Anesthesia may be induced by a general anesthetic to abolish the usual pain of labor and of surgical procedures; to produce muscular relaxation in tetanus, herniæ, dislocations, and fractures; and to aid in diagnosticating abdominal tumors, joint-diseases, fractures, and malingering.

Death-rate from Anesthetic Agents.—Hewitt combines the statistics of Julliard and Ormsby, with the following result ("Anesthetics and Their Administration"):

ANESTHETIC.	TOTAL NUMBER OF ADMINISTRATIONS.	TOTAL NUMBER OF DEATHS.	DEATH-RATE.
Chloroform	676,767	214	1 in 3162
	407,553	25	1 in 16,302

Hewitt finds that during the last forty years only thirty fatalities are recorded as produced by nitrous oxid, and he thinks several of these should be excluded. It is practically certain, however, that many deaths, or at least some deaths, have not been recorded.

Seitz collected 16,000 instances of anesthesia by chlorid of ethyl, with one death. I have seen anesthetics (particularly ether) given many thousand times. For five years I gave ether and chloroform for Prof. Keen. I have witnessed three deaths that at the time were thought to be directly due to anesthetics, and two of them were so caused. One death resulted from pouring a quantity of chloroform upon an Allis inhaler, the bandage of which was saturated with ether. At the time the chloroform was poured in the inhaler the patient had just been struggling and consequently was breathing deeply. One death resulted from giving ether on a thick cone made of several towels with paper between the folds. The towels were saturated with ether, the patient got no air at all, and was asphyxiated, as she might have been had the cone only been wet with water. The third case was a man who had an impacted hip fracture. He became cyanotic under ether and died. The death was supposed to be due to ether, but necropsy discovered fat emboli in the brain and lungs.

Preparation of the Patient.—Whenever possible, prepare a patient before administering a general anesthetic and prepare him, if the case admits of it, during two or more days. Heart disease is not a positive contraindication to surgical anesthesia. It is quite true that anesthetics are dangerous to people with fatty hearts, but shock is also dangerous, and the surgeon stands between the Scylla of anesthesia and the Charybdis of shock. Gallant truly says that not enough attention is paid to the "character of the pulse"

and action of the heart before operation, by which anesthesia, and after the operation is over, and th sary stimulation and overdriving a heart which i Always examine the urine if the nature of the cas is found, operation is not contraindicated; but greater, and certain dangers are to be watched If much albumin is present, postpone operation If sugar is found, the danger is considerable, as develops. The percentage of sugar does not deter Coma may arise when only a little sugar is prese there is a considerable amount. The presence of ominous than is the presence of sugar. Emp purgation a number of hours before anesthetization. six to twelve hours' rest before operation. The usi cathartic the evening before operation and an ene the operation. Frequently the nature of the case does not permit of preliminary emptying of the int of cathartics. During the twenty-four hours prece be taken in small amounts and in forms easily of or so before operation there is usually impaired dig should be put upon the stomach. In the morning operation is to be performed at an early hour, but order a little brandy and beef-tea. If the open give a breakfast of beef-tea and toast or a little food within three hours of the operation, but bran quired. If the stomach is not empty at the time most inevitable, and portions of food may enter th contains no food, vomiting is far less likely to happe vomited matter should enter the windpipe, it may chiefly of liquid mucus. In cases of intestinal obs been stercoraceous vomiting there is much danger t ing anesthetization. In some cases of intestinal obs istration of the anesthetic, and during the anestheti brown fluid may flow without effort from the mo tation of stercoraceous material is profuse, sudde flood the bronchial tubes during inspiration and In a case in which stercoraceous vomiting has occ before administering the anesthetic. If a patient is too weak to permit lavage, a local anesthetic a general anesthetic. Vomiting while the patien an anesthetic is dangerous in any case, because of which precedes and follows it. If a patient sle an operation, he will probably take the anesthet poorly. Effort should be made to obtain a ni expedient is a hot ammonia bath, followed by a rul It may be necessary to administer trional or brom before giving the anesthetic let the patient drink a

<sup>\*</sup> Medical Record, February 2, 1899. † A. Ernest Gallant, Med. Record, De

material protects the stomach from the irritant effects of any anesthetic which may be swallowed. Before giving the anesthetic see that artificial teeth are removed and that the patient does not have a piece of candy or a chew of tobacco in the mouth. Always have a third party present as a witness, because in an anesthetic sleep vivid dreams often occur, and erotic dreams in women may lead to damaging accusations against the surgeon. Place the patient recumbent. The effort should be to place him in as comfortable a position as possible if this position is consistent with operative necessities. Put a small pillow under him, so as to support the normal lumbar curve and prevent postoperative backache (page 1201). See that the clothing is loose, particularly that there is no constriction about the neck and abdomen. Do not have the head high unless this position is demanded by the exigencies of the operation. The anesthetist must have a mouth-gag and a pair of tongue forceps. It is very wrong to say that a mouth-gag and tongue forceps are never necessary. It is quite true they are often used when not needed, but this does not justify us in being without them when they are needed, and they may be needed very badly. The anesthetist should also have a pair of artery forceps and some small gauze sponges to swab out the mouth and throat. A hypodermatic needle in working order, and solutions of strychnin, atropin, and brandy are to be in a readily accessible place, oxygen must be ready for administration, and it is well to have an electric battery at hand. Accidents, it is true, are rare, but they may happen at any time, and hence the surgeon should always be prepared for them. Any danger which arises must be met with promptness and decision, or action will be of no avail. Many surgeons give a hypodermatic injection of morphin a short time before operation, to steady the heart, to prevent vomiting during anesthetization, to shorten the stage of excitement, to prevent rigidity, and to aid the bringing about of insensibility with very little of the anesthetic. This method has been tried by many during the last forty odd years. It is used in drunkards (as their muscles tend to remain rigid), in those whom it is difficult to make completely unconscious, in neurotic individuals, and in badly frightened subjects. Its greatest use is in operations about the mouth and face, for in these procedures an anesthetic is usually given intermittently and a preliminary dose of morphin keeps the patients from rousing during the intervals. There are, however, objections to morphin before anesthesia, and its use should be the exception and not the rule. It should not be used in children, in cases of stupor, or in cases in which the respiratory center is disordered. It depresses the respiration, lowers temperature, and thus perhaps increases operative shock, interferes with the pupillary phenomena of anesthesia, delays awakening from the anesthetic sleep, adds to subsequent abdominal distention and headache, and actually favors post-anesthetic vomiting. Hewitt ("Anesthetics and Their Administration") says that several recorded fatalities were due to the combination. If the surgeon determines to give morphin, he gives gr. 1 to 1 twenty minutes before the anesthetist begins to give the anesthetic. Hewitt (Ibid.) says: "The anesthetic should be given until the usual signs of anesthesia commence to appear. It should then be discontinued for a few moments and only reapplied as occasion may require. As little as possible of the ether or chloroform should be subsequently administered; the conjunctival reflex should be retained." In the clinic of the Jefferson Hospital the elder Gross long used as a routine the preliminary

administration of opium, but during his later yea His successor, the younger Gross, used morphin h ally. In some cases we may anticipate trouble from may occur in drunkards; in fat, thick-necked individitype, who are short of breath and congested in appearance of the lungs, bronchi, pharynx, lary emphysema, chronic bronchitis, croup, cancer of the uals suffering from fatty heart or valvular incompithat an individual without teeth and with stenosis of cyanotic under an anesthetic, because the lips and drawn in like valves during inspiration.

Ether and Chloroform.—The two favorite chloroform. Only the very best ether or chloro is a good plan, in order to lessen bronchitis, to of Pinus pumilio in the proportion of 20 drops to tralbl. f. Chir.," June 1, 1901). Chloroform is 1 in general cases, though it is more agreeable, les kidneys, and quicker in its action. Chloroform is than in cold countries. In fact, in the tropics it difficulty to use ether because of its great volatility in campaigns, because less is required and transpofrom chloroform is quicker and quieter than that I vomiting lasts longer than ether-vomiting. Chlor and even fatal syncope. Hare's experiments on a form may kill by respiratory failure occurring se vasomotor center; but certain it is that clinically is paralysis of the heart, and this condition may death may occur almost before an attempt can be r Hill has proved that most chloroform-deaths that to of the anesthetic has been taken arise from paral Sudden death, when inhalations of chloroform h be due to the irritant vapor acting on the nasal mu nasal reflex and powerfully stimulating cardiac inl danger it does so usually through the respiration, a is generally time to undertake means of resuscita to be successful. Chloroform is preferred to eth children under ten years of age, in whom ether bronchial mucus, which may asphyxiate; for peop from myocardial disease, at which age most perand ether chokes them up with mucus. Ether which at the latter age are apt to be weak or disease even to infants (if they are free from bronchitis) marked respiratory trouble. Chloroform is given be used about the face, neck, or mouth, because and chloroform vapor will not. Chloroform is when moderate anesthesia only is required, and for and nose. In cleft-palate operations chloroform is it causes but little cough and salivary flow. In which is overlaid by a vein ether greatly enlarges

embarrassment to an experienced surgeon. In goiter operations ether will decidedly enlarge the veins. In fact, most goiters should be removed with the aid of local anesthesia only. Chloroform is particularly dangerous when there is myocardial disease, and is apt to produce cyanosis and embarrassed respiration. In valvular heart disease chloroform is more dangerous than ether, and even in functional heart trouble it is an undesirable anesthetic. It should not be used in those who smoke or chew tobacco to excess, or who overindulge in coffee or alcohol. Chloroform is more dangerous in shock than ether. A patient in dangerous shock requiring operation should, if possible, have the nerves coming from the part injected with cocain so as to prevent further shock by introducing a "physiological block"-Crile (page 262). Chloroform is preferred for patients with difficult respiration from any cause other than heart disease (emphysema, bronchitis, or pulmonary tuberculosis), and for patients with kidney disease. I am convinced that etherization is sometimes responsible for a latent area of pulmonary tuberculosis becoming active. Some surgeons do not use ether in abdominal operations because they believe it may cause persistent oozing of blood, but this view is not in accord with the author's experience. Ether is the best and safest anesthetic for general use. It is much safer than chloroform in valvular disease and functional heart trouble. It is dangerous in myocardial disease, but not nearly so dangerous as chloroform. In valvular disease without heightened arterial tension it is reasonably safe, but in valvular disease with heightened arterial tension it is dangerous. Ether is dangerous when atheroma exists. Both ether and chloroform may induce changes in the blood.\* In practically all cases they produce a diminution of hemoglobin and leukocytosis. In some cases they produce alteration in the shape of the corpuscles. These changes are especially marked in anemic blood. Ether produces distinct leukocytosis, probably toxic in origin. These blood-changes indicate that prolonged anesthesia may militate against recovery from a severe operation. If a patient's hemoglobin is below 30 per cent., a general anesthetic should not be given. During the state of anesthesia the temperature drops from one to three degrees or more, hence the patient should be carefully covered during the operation. The question as to the effect of ether on the kidneys is much disputed. Most surgeons believe that it tends to cause albuminuria or increase existing albuminuria. Nitrous oxid is very dangerous when there is vascular degeneration, and it may induce apoplexy. It is also dangerous if the air-passages are narrowed as by a goiter. In giving ether or chloroform the administrator must devote his undivided attention to the task. He must note every symptom, must order or carry out proper treatment for complications, and must keep the operator informed as to the necessity for haste. The anesthetist must be a man who has a wholesome respect for ether and chloroform, although not afraid of them.

Can an anesthetic be administered to a sleeping person without waking him? I know that chloroform can be so given, for I have succeeded in giving it to a child without breaking the slumber. Probably, in most cases, an attempt will fail, but in some it will succeed. Stone ("Cleveland Med. Jour.," Jan., 1902) reports successful administration to sleeping children

<sup>\*</sup> See the author on the "Blood-alterations of Ether-anesthesia," Medical News, March 2, 1895, and also the author and Kalteyer in The Proceedings of the American Surgical Assoc. for 1901.

and also the chloroforming of a resident physician while asleep. Paugh ("Jour. Amer. Med. Assoc.," May 18, 1901) reports three successes with children. Ether, because of the irritant nature of its vapor, would be more

apt to arouse a sleeper than would chloroform.

Administration of Chloroform.—Chloroform should be given only by a trained man. In fact, safety in giving chloroform is dependent upon skill and experience more than in giving ether. The most dangerous periodic is when the patient is incompletely anesthetized, but is going under. Most deaths happen at this time. In administering chloroform have at hand a mouth-gag, tongue forceps, artery forceps, small gauze sponges, a clear towel, a hypodermatic syringe, solutions of strychnin, atropin, and brandy an electric battery, and a can of oxygen. Use only pure chloroform. The patient must be recumbent. No special inhaler is required, but the drug may be given upon a thin towel, a napkin, or a piece of lint. The mask of Skinner is very useful (Fig. 701). Junker's inhaler is used by many anesthetists (Fig. 700). In operations about the face Souchon's instruments serviceable. Souchon's apparatus is so arranged that chloroform may

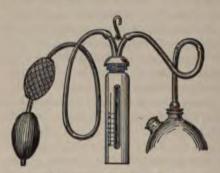


Fig. 700.-Junker's inhaler.

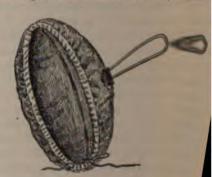


Fig. 701 .- Skinner's mask.

be given through a tube which is introduced through the nose, the instrum being well out of the way of the operator. Some surgeons cocainize the Barres before giving chloroform, so as to prevent the supposedly dangerous pasal refler (Rosenberg). It is a good plan to smear the lips and face with cosmolin to prevent blistering. The chloroform-vapor must be well mixed with air, The chloroform is sprinkled on the fabric with a drop-bottle. Raise the napkin well above the mouth, add five drops of chloroform, and tell the patient to take deep and regular breaths, but do not tell him to breath cibly. Forcible respiration may lead to cessation of respiration. A few more drops of chloroform, and when the patient grows so accustom it that it does not choke, turn the wet part of the fabric toward the face place it near the mouth; do not touch the mouth with the wet lint, bec it will blister. If the drug is given gradually, struggling is not usually vic or prolonged. Never pour on a large amount at one time. Keep the jaw pushed forward during the time the chloroform is being given. Com and vomiting at this time mean that the vapor is too strong. During stage of excitement do not suspend the administration of chloroform una respiration becomes difficult, in which case suspend it until the patient ta-

one or two respirations. If the patient struggles, do not hold him and push the administration of the drug. He holds his breath while struggling, and as struggling ceases takes full, deep breaths. If the inhaler is saturated with chloroform, he may inhale a dangerous amount during the deep respiration after struggling. Chloroform given in considerable amount when the patient is breathing deeply from the effects of ether is unsafe. If chloroform is given subsequent to anesthetization by ether, it should be given gradually and well mixed with air. When the patient becomes anesthetized, give just enough of the drug to keep him so. After the patient has been anesthetized, hiccough usually means that vomiting is going to occur. If vomiting occurs at this time, more chloroform must be given to abolish the reflexes. Deep and sighing respiration and repeated swallowing indicate that more of the anesthetic is required. Stop the administration or give very little when shock becomes evident or when there is profuse hemorrhage. Chloroform-vapor is not inflammable, hence it is safer than ether when a hot iron is to be used about the face and when there is a lighted lamp or a stove in a small room; but the presence of a naked gas-flame decomposes chloroform into irritant products of chlorin, which sometimes cause the patient and the surgeon to cough (COCl.).

Chloroform and Oxygen.—The use of this mixture was suggested by Neudorfer. Some anesthetists advocate the use of chloroform and oxygen, asserting that it does not produce spasm of the glottis or muscles of respiration, that it does not produce cyanosis or weakness of circulation, that it does not irritate the kidneys, is safer to life than pure chloroform, and is less often productive of severe and prolonged vomiting. These alleged advan-

tages are probably stated with rather undue emphasis, although I do believe the mixture has less tendency to produce cyanosis than has the pure drug, does not so often induce vomiting, and is somewhat safer. Hewitt does not think that the method offers any "special advantages" ("Anesthetics and their Administration," by Fred. W. Hewitt). If this method is used, a bag containing oxygen is attached to the hand-bellows attachment of a Junker inhaler, and oxygen is forced through the chloroform and flows to the face-piece.

Administration of Ether.—The administration should not be intrusted to a novice. The anesthetist should be one of your best men. Ether is best given by a partially open inhaler.



Fig. 702.-Allis's ether-inhaler.

The most satisfactory appliance is Allis's inhaler (Fig. 702). This inhaler secures a plentiful supply of air. Before being used, the metal frame is scalded, dried, and threaded with a clean gauze bandage. The end of the frame which is to be toward the mouth is covered with one layer of gauze. The frame is then inserted in a clean metal case and the case is wrapped in a clean towel. Probably the safest way to administer ether and the most comfortable for the patient, is to take a piece of gauze or an Esmarch inhaler and give the drug drop by drop, the drops following each other in regular sequence. This is

known as the *drop method*. Many surgeons prefer of inhaler is popular in England (Fig. 703). F is the ether through which the air-current passes; B is an Inparatus there is no provision for the entrance of fresh voir C on the tube t the amount of current passing of lated. When this apparatus is used, the ether vapor expired into the bag and is rebreathed. This inhale is very useful; but any lack of watchfulness or sk and the very young, the senile, the anemic, and for the Allis inhaler.

An admirable detailed account of anesthetizal will be found in Mr. Frederic W. Hewitt's treatise Administration" (page 272), and in Mr. Dudley "Anesthetics, their Uses and Administration" (page have at hand the same drugs and appliances as and keep the lower jaw pushed forward during t



Fig. 703.-Clover's portable regulating et

anesthetizing by Allis's inhaler, take every care through on to the face and into the eyes. If it does vapor irritates the eyes and boracic acid solution shaduring the administration to flush out the conjuto grease the face and lips with cosmolin. Place mouth and nose, let the patient take several breaths, apour a few drops of ether into the inhaler, let the breaths, and so on, gradually increasing the amour struggle, diminish the amount of ether for a time, but tell him to breathe forcibly. Forcible breathing is respiration. Never suddenly add a large amount coughing and often vomiting. When the patient be ized, give a very little ether as often as is required to

When bleeding is profuse or shock is marked, suspend the administration of ether or give very little of it. If a hot iron is to be used about the face, remove the inhaler and fan away the ether before bringing the cautery near. Have any light set high up, as ether vapor is heavier than air, and no explosion is possible until it reaches the level of the flame. If the vapor takes fire, cover the patient's mouth and nose with a towel. If he rolls his eyes from side to side, if the respirations are deep and sighing, if there are repeated movements of swallowing. more anesthetic should be given (Tarnowsky). Hiccough is often preliminary to vomiting, and always means that the reflexes are returning.

The patient should be kept in a condition in which he feels no pain, makes no movement, and is not rigid. In this condition the cutaneous reflexes are abolished, the breathing is regular and quiet, the color is good and the pupils react to light, though slowly. Just enough anesthetic must be given to cause the patient to pass into this condition and remain in it. To give any more is to poison him. The amount necessary varies with the individual and the operation, and requires skill, experience, and attention on the part of the anes-

The old idea that we must poison a man into dangerous coma has been abandoned. When the breathing becomes louder, more rapid, or spasmodic, it means that reflexes are returning and a little more anesthetic should be

Ether and Oxygen.—This mixture is useful in certain cases in which respiratory difficulty exists, particularly in empyema. If during the administration of ether cyanosis tends to occur, it is often advantageous to give oxygen with the ether. The process of anesthetization by ether and oxygen is somewhat slower than by ether vapor mixed with air. It can be given by inserting beneath the Allis inhaler or pushing deep down into it, from above, a tube attached to a reservoir of oxygen and from which a stream of oxygen emerges.

Rectal Etherization.—Pirogoff suggested this method in 1847 and Roux employed it the same year. The method is only used in operations about the face, tongue, nasopharynx, larvnx, mouth, and larvnx; in other words, in cases in which, were the ether given by inhalation, the operator and anesthetist would interfere with each other. The rectum should be emptied by a purgative enema the day before the operation, and again the morning of the operation, and a short time before giving the ether the rectum should be irrigated with warm salt solution. A dose of laudanum is given a few hours before. We should employ an apparatus of the type of Buxton's, which prevents liquid ether from passing into the rectum.

A tube containing ether is set in a vessel containing water at a temperature of 122° F. The ether tube is joined by a glass tube and rubber pipe to a glass globe, and the globe is connected by a rubber pipe to the tip, which is inserted into the rectum. If ether vapor condenses into liquid in the glass globe the globe should be at once emptied. During the administration abdominal distention occurs from unabsorbed ether, and from time to time the administration should be suspended temporarily to permit the gas to escape, otherwise too much will be given and prolonged stupor and postoperative colic may result. It takes much longer to obtain unconsciousness by rectal administration than by inhalation. The method must never be used if the intestines are irritated or inflamed (Dumont, in "Corr-Bl. f. Schweizer Aerzte," Dec. 15,

1008). The method has never come into general intestine, often produces colic, and sometimes is said ("Anesthetics and Their Administration," by Fred Buxton, however, has employed it in many operation and larynx, and in some operations for empyema, etherization does not produce a sense of suffocation

short, and struggling is trivial or absent.

Anesthetic State from Ether or Chloro an anesthetic produces irritation of the fauces, of secretion of mucus, acts of swallowing, dilatation and sometimes struggling (especially in children as vapor is given at once in concentrated form, coug cause cyanosis. If the anesthetic is given careful the respirations become rapid and often convulsiv quent, and the patient passes into a condition of preservation of sight and touch, loss of hearing pain and sensibility, and often with illusions o stage the patient may struggle, and while efforts him, cyanosis may occur. From the stage of ex many subjects (strong men and drunkards) pas in which the muscles become firmly fixed, the breat tions stertorous, and the face bluish and congest the anesthetic tends to cause rigidity, and a ski to avoid its production; because it is dangerous of insensibility; the pupils are contracted, but react s thesia is deep, the contracted pupils will not react to found, the pupils dilate, but will not react to light is gone; the lids are closed; if the arm is lifted an as a dead weight; the skin is cool and moist, and respirations are easy and shallow; the pulse is sk unconsciousness to pain. The loss of conjunct accepted sign that the patient is unconscious. In is soon exhausted by touching the eye, and the sign is to be anesthetized, the administrator places his f The child grasps the finger, and relaxes its grasp wi

Always bear in mind that dilated pupils reacti with preserved conjunctival reflex mean that an that contracted pupils reacting to light and withou moderate anesthesia; that contracted pupils not rea conjunctival reflex mean deep anesthesia; that d to light and associated with lost conjunctival refle found anesthesia. The pupillary phenomena are ve but unfortunately they are absent at some stage of the Inequality of the pupils is not unusual and fixation of occur. A preliminary dose of morphin interferes w ena. Sudden dilatation with fixation is always ve and pallor may be due to nausea, but always requir iting may be due to forcing strong vapor upon the due to his partially emerging from a state of insensi-

Watch the pulse carefully to see if it becomes very weak, irregular, abnormally slow, or abnormally fast. Syncope may be due to nausea, shock, hemorrhage, or the giving of too much of the drug. Watch the respiration, and do not forget that the chest-walls and belly may move when no air is entering the lungs; hence always listen to the breathing. Cyanosis is a dusky or bluish discoloration of the skin. This condition indicates want of oxygen in the blood. The individual may have been cyanotic or predisposed to cyanosis to start with; cyanosis may be due to pressure; to cough early in the administration; to struggling during the stage of excitement; to gathering of mucus in the respiratory tract; or to rigid fixation of the respiratory muscles. It may also be due to obstruction of the air-passages by some foreign matter, as blood or vomit, lodging in the bronchial tubes, windpipe, larynx, or pharynx; falling back of the tongue (swallowing of the tongue); closure of the epiglottis; or to the glottis being pushed against the pharvngeal wall by bending the head forward. Some patients with occluded nostrils may fail to get enough air because of closure of the lips. A patient may, while taking an anesthetic, lie perfectly quiet and appear to "forget to breathe." Ether and chloroform can certainly cause shock. Neither drug keeps nerves from conveying stimuli and each produces a fall of blood-pressure, chloroform directly by its action on the vasomotor center, ether by overstimulation of the vasomotor center (Buxton, in "Proceedings of the Royal Soc. of Med.," April, 1909). Each produces a fall of temperature. Buxton heartily condemns the once common belief "that evidences of shock during a surgical operation are a proof that an insufficient quantity of the anesthetic has been given and that the symptoms of shock can be abrogated by increasing the depth of the narcosis" (Ibid.). Shock is manifested by deathly pallor, weak, rapid, and irregular pulse, slow respiration, cold extremities, and a drenching sweat. Edema of the lungs occasionally arises during or after anesthesia.

Treatment of Complications .- Vomiting due to too much anesthetic is corrected by giving a few breaths of air; vomiting due to incomplete anesthesia is amended by giving more of the vapor. When the patient vomits, hold the head over the edge of the bed, separate the jaws with the gag, and wipe out the vomited matter, mucus, and saliva. Shock is treated by diminishing the amount of the anesthetic given, by the hypodermatic injection of atropin (atropin is very useful when there is a profuse sweat), by the administration of hot saline fluid by the rectum, by surrounding the patient with hot-water bottles, or by wrapping him in hot blankets, and by lowering the head of the bed. Syncope is sudden cerebral anemia usually due to a reflex cause. A tendency to syncope requires lowering of the head of the bed, suspension of the anesthetic, and hypodermatic injection of strych-In extreme syncope, which is most apt to occur from chloroform, do not wait for breathing to cease, but suspend the anesthetic, lower the head of the bed, open the mouth with the gag, catch the tongue, and make rhythmical traction while an assistant is making slow artificial respiration. If the patient does not at once improve, invert him completely, holding him by the legs and continuing artificial respiration by compressing the sternum (Nélaton). By continuing artificial respiration the blood is urged on through the heart. Give hypodermatic injections of atropin, ether, or even of ammonia. Put mustard over the heart and spine. Employ faradism to

the phrenic nerve (one pole to the epigastric region, the other to the right side of the root of the neck). Let fresh air into the room, put hot-water bottles around the legs, apply friction to the extremities, wrap the patient in hot blankets, give an enema of hot salt solution, and hold ammonia to the nose. In some cases of chloroform poisoning direct heart massage has been successfully employed. In Sencert's successful case an operation was being done for gall-stones when collapse occurred, and the surgeon stroked and kneaded the heart through the diaphragm. In a case recorded in the "Brit. Med. Jour.," Nov. 18, 1905, respiration and pulse had ceased three minutes when the abdomen was opened and the heart was kneaded. Recovery ensued. Müller, of Hamburg, advocates exposing and opening the pericardium to perform massage, introducing oxygenated salt solution into a vein, opening the trachea, and performing artificial respiration. Leonard Hill holds that in the failure which arises soon after administration of chloroform is begun the trouble is due to vasomotor paralysis with starvation of the nerve-centers. In such a case he applies abdominal compression and inverts the patient, making artificial respiration at the same time. In the failure which occurs after considerable chloroform has been taken there are paralytic distention of the heart, fulness of the venous system, and loss of the compensations for the hydrostatic effects of gravity. In such a condition empty the distended heart of venous blood by raising the patient into an erect position; and after a moment place him recumbent and make artificial respiration.

"Forgetting to breathe" is met by removing the inhaler and waiting a moment; a breath will usually be taken soon; but if it is not taken, somewhat forcibly knead the structures in the arm-pit. If this fails, open the mouth and pull forward the tongue; this causes a reflex inspiration. Cyanosis is practically not encountered when oxygen is given with ether or chloroform. Cyanasis, if slight, and due to cough or struggling, is met by removing the inhaler while the patient takes a breath or two of air. If position is responsible for cyanosis, correct it. In empyema, lying upon the sound side may produce it, and obstruction to breathing may be due to bending down the head. If due to stenosis of the nares in a person without teeth, hold the lips apart with a finger. If due to collection of mucus, wipe the mucus out of the mouth by means of bits of gauze firmly clamped in forceps; raise the shoulders, extend the head and place it on its side in order that mucus may run out of the angle of the mouth; and give a dose of atropin. If the amount is large and the secretion persistent, it may be necessary, especially in children, to empty the respiratory passages by inverting the patient. In cases of excessive bronchial serve tion we fear the development of pulmonary edema or postoperative bronchopneumonia.

Dudley W. Buxton points out that duskiness will often pass away if ether is removed, one or two inhalations of chloroform given, and ether then continued. If in any case cyanosis is severe or grows worse, suspend the drug, dash cold water in the face, force open the jaws, pull forward the tongue, make artificial respiration until a breath is taken, and then give oxygen for a time. If these means fail, stretch the sphincter ani and bleed from the external jugular vein. If a breath is not now taken, do trache-otomy. In respiratory or heart failure forced artificial respiration by Fell's

method is of great value (page 894). In Fell's method a tracheal tube is inserted, and by means of a foot-bellows air is forced into the lungs, after first passing through a warming chamber. Instead of a tracheal tube, we may use a face-mask and an intubation-tube. "Swallowing the tongue" is corrected by pulling the tongue forward. If it tends to recur, lay the head upon its side or keep the tongue anchored with forceps. Closure of the epiglottis is corrected by pulling the patient's head over the edge of the table and pushing strongly back upon his forehead. This maneuver lifts the hyoid bone, and with it the epiglottis. The epiglottis can be lifted by passing a spoonhandle or the index-finger over the dorsum to the base of the tongue and press-



Fig. 704.-Artificial respiration, first movement.

ing forward. If, in obstruction to respiration, the above means fail, make artificial respiration at once; if obstruction continues, perform tracheotomy. Edema of the lungs is treated by instant venesection, the inhalation of nitrite of amyl, and the administration of stimulants and nitroglycerin hypodermatically. Sometimes, duing the anesthetic state, the muscles of the belly become very rigid, a condition which greatly interferes with an abdominal

operation. It may arise during cyanosis, and if so caused, is amended, as cyanosis abates, under proper treatment. In some cases it is due to the fact that sufficient anesthetic has not been given. If the air-passages are



Fig. 705.—Artificial respiration, second movement.

obstructed, abdominal rigidity is apt to arise. In some cases it seems impossible to overcome it with ether. In such a case, if the anesthetist is a trusted man, anesthetize the patient with gas and ether and then give chloroform (Blumfield, in "Lancet," May 31, 1902).

Artificial Respiration.—Laborde's Method.—Place the patient on his back with the head lower than the body, all the clothing loosened, and the jaws wedged apart, and wipe the mucus from the throat and mouth. Grasp the tongue with forceps, and once in every four seconds pull it quickly

and strongly forward and then permit it to go back. It may be necessary to keep up this proceeding for thirty minutes or even more.

Laborde's method should be associated with "concentric thoracic and upward abdominal pressure applied in a rhythmic manner by two assistants at the time of relaxation of the tongue."\* Laborde believes that tongue-

traction causes contractions of the diaphragm.

Sylvester's Method (Figs. 704, 705).—The patient is placed recumbent with the foot of the bed raised. The surgeon grasps the arms just above the elbows, and draws them outward and upward until they are nearly perpendicular (Fig. 704); they are held perpendicular for two seconds, while air is entering the lungs; the arms are then lowered and pressed against the sides of the chest (Fig. 705) for two seconds, during which time the chest is emptied as in expiration. These movements of elevation and depression are made twelve or fifteen times a minute.

The Reaction from Anesthesia.—When ether or chloroform is given, a considerable quantity is swallowed and either drug irritates the stomach and creates nausea and often vomiting. The longer the operation. the more of the anesthetic enters the stomach, and the greater the liability to subsequent vomiting. At the termination of a prolonged operation upon ar adult, if the patient's condition admits of it, and if the nature of the operation does not forbid it, I like to have a stomach-tube passed and the stomach well washed out with warm water. The washings smell strongly of the anesthetic, and the procedure greatly lessens the severity and frequency of post-operative vomiting (Geo. S. Brown, in "Surgery, Gynecology, and Obstetrics," August, 1005). After the administration of the anesthetic has been suspended and the operation has been completed, the temperature is usually subnormal. The patient must be watched until consciousness return If he is left alone, a change of posture may lead to arrest of feeble respiration the assumption of the erect position may cause fatal syncope, or mucus oc vomited matter may block the air-passages and cause suffocation. position to place him in is the recumbent, the head being level with the box or somewhat lower, and the side of the face resting on the pillow. Shock treated by ordinary methods. The inhalation of oxygen is of great value rousing a patient from the state of anesthesia, and will often prevent vomition If vomiting occurs, the head should be upon its side or should be held over the edge of the bed, and after the spell of vomiting the mouth must be wiped clean. The face should be washed with cold water and be fanned rather actively. It is the routine practice of some surgeons to administer vinegar by inhalation during the reaction from an anesthetic. This proceeding sometimes seems to prevent vomiting. Some patients awake from anesthesia 35 from a quiet sleep; others are noisy, turbulent, and violent. The duration of the period of reaction varies with the anesthetic used, the amount given, and the personal tendencies of the patient. The patient must not be allowed to sale for several hours at least. No food is to be allowed for at least six hours Unless the operation was upon the stomach, I do not forbid water, but allow patient to drink freely of hot water. This dilutes any irritant material ir stomach and dissolves mucus, and if vomiting does occur, it serves to wast stomach out. All fat patients, all patients with respiratory difficulties, and in

<sup>\*</sup> Joseph D. Bryant's "Operative Surgery."

whom we apprehend respiratory complications, should be placed in a sitting or, at least, a semi-erect posture as soon as reaction from anesthesia is obtained. If this plan is followed, ether-pneumonia and other respiratory troubles will very seldom develop.

After-effects of Anesthetics.-Vomiting.-Vomiting may occur in spite of all we can do, and may persist for hours, greatly exhausting the patient and doing infinite harm, it may be, if the operation were upon the brain or an intra-abdominal structure. If vomiting continues, forbid food, Very hot water in doses of a teaspoonful should be given at frequent intervals. A draught of hot water may relieve the condition by washing out the mucus from the stomach. Other remedies which may succeed are: inhalations of vinegar, hot black coffee by the mouth, a mustard plaster over the stomach, fresh air in the room, small pieces of ice placed in the mouth and sucked, small doses of iced champagne, and drop doses of a 3 per cent. solution of cocain or 3-drop doses of a 5 per cent. solution of eucain. The best remedy for persistent vomiting is lavage of the stomach. Some persons, as Dudley W. Buxton points out, suffer greatly from nausea, although there is little or no vomiting. In such cases Buxton uses mj of tincture of nux vomica in a teaspoonful of hot water every ten minutes until six doses are taken. If this plan fails, he gives drop doses of wine of ipecac or minim doses of dilute hydrocyanic acid.\*

Vomiting from chloroform is usually more difficult to check than vomit-

ing from ether.

Backache.—This is a very common and often a very distressing consequence of anesthesia. It is often complained of soon after consciousness is regained, it may persist for several days, and it is a not uncommon cause of wakefulness. It is usually greatly aggravated by turning and twisting, and by attempting to rise up. The pain is located in the lumbar and sacral regions and is often accompanied by rigidity of the lumbar muscles. Various explanations have been given of it. One view is that it is due to renal congestion. Inother, that it results from congestion of the spinal cord. I believe that the cal explanation is that of John Dunlop ("N. Y. Med. Jour.," July 10, 1909), z.: "The patient during the operation lay upon a flat table without support the lumbar curve, consequently the sacro-iliac synchondroses were strained. The backache may be largely prevented by placing a small pillow so that it will poport the lumbar curve during anesthesia."

Respiratory disorders are more often noted after ether than after chloron. Bronchitis may follow or bronchopneumonia (ether-pneumonia).
piratory difficulties may be due to chilling the patient by bringing him
a warm operating-room through a cold hall and into a cool bedroom.
Inchopneumonia is especially common in septic patients, and may be
n some cases to septic emboli and in others to aspiration of septic material
he bronchi (cases of cancer of tongue and pharynx, and cases with stereous vomiting). They are treated by ordinary methods. If chlorois given when a gas-light is in the room, the vapor is decomposed
tertain highly irritant products are formed, which, when inhaled,
the laryngeal spasm and possibly bronchitis. The irritant material
bably COCl<sub>3</sub>. The treatment is freely to admit fresh air into the
and to have the patient inhale oxygen or vinegar. Ether-pneumonia

must not be confounded with postoperative pneumonia, described by Wm. H. Bennett.\* This latter condition may arise from seven to fourteen days after operation in robust, gouty people, and is usually unilateral. If the patient is placed in a sitting position, or at least, semi-erect in bed, as soon as he reacts from the anesthetic the danger of serious respiratory disorder will be at a minimum.

Renal Complications.-After the administration of an anesthetic, blood, albumin, or sugar may appear in the urine, and the secretion may become scanty or even be suppressed. It is usually maintained that chloroform is less apt to irritate the kidney epithelium than is ether, but there has been much dispute on this point. If casts and albumin are present before anesthetization, the condition may be rendered worse when ether or chloroform is given. If neither casts nor albumin are present, they will not be so apt to appear after taking chloroform as after taking ether, but if they do appear after chloroform, they remain longer than after ether (Legrain). The truth of the matter probably is that if the kidneys are healthy, a small or moderate amount of either drug is not particularly irritant; but if the kidneys are diseased, a small amount, and even if they are healthy, a large amount, of either drug produces decided renal irritation. Chloroform is less irritant because less chloroform than ether is given to secure and maintain anesthesia. Scantiness or suppression of urine may be due to operative shock rather than to ether or chloroform. If the urine becomes somewhat scanty or if albumin appears in it, give non-irritant diuretics, diaphoretics, and cathartics, and employ enteroclysis. If the urine becomes very scanty, use hypodermoclysis. If post-operative suppression arises, it is the usual custom to give intravenous infusion of hot saline fluid, but I am doubtful of its value. Exposure of each kidney in the loin and incision of its capsule to relieve tension is justifiable and may do good.

Acid Intoxication .- This condition has been called "delayed poisoning." acetonuria, and acidosis. It is known that even in healthy urine there may be a trace, but a bare trace, of acetone. In certain cases in which dangerous symptoms arise after anesthesia, the urine contains albumin, casts, and either diacetic acid or acetone or both of these substances. Acid intoxication is very much commoner after the administratin of chloroform than of ether, but may follow the giving of any general anesthetic. It may occur in individuals whose tissues contain areas of fatty degeneration, but it also occurs in those entirely free from degeneration; in fact, children particularly suffer in this way after the use of chloroform. The actual operation has nothing to do with the trouble, and sepsis is not causative. The drug used as an anesthetic causes acute fatty degeneration of the liver, quantities of toxins are formed, and these toxins cause the symptoms. Acetone, diacetic acid, and beta-oxybutyric acid are by-products of the process and are antecedents or precursors of acetone. The symptoms arise after the patient has emerged from anesthesia and reacted from shock. There is persistent vomiting of thin and foul fluid, the patient is extremely restless and much excited, there may be delirium, but dulness and heaviness may take the place of restlessness and excitement and coma may arise (J. A. Kelly, in "Annals of Surg.," Feb., 1905). Usually the temperature is subnormal, but sometimes there is elevated temperature. In many cases jaundice arises. There is an odor of acetone on the breath. The urine con-

<sup>\*</sup> Practitioner, Dec., 1896.

tains albumin and casts, and either diacetic acid or acetone or both. Some cases recover, but most of them die in from one to five days. A knowledge of this condition explains some otherwise inexplicable deaths, and also some cases of retarded convalescence. In acid intoxication there is fatty degeneration of the kidneys, of the liver, of the suprarenal glands, and of the gastric mucosa. The occurrence of such a condition is an impressive admonition that a surgeon should operate quickly, that as little of the anesthetic should be given as possible, that the urine should be carefully examined each day after operation for certainly several days, and that chloroform should not be used for prolonged administration. Severe acid intoxication is treated as follows: Encourage skin activity by wrapping the patient in blankets and surrounding him with hot-water bags. Give salt solution with bicarbonate of sodium by hypodermoclysis and by the rectum. In mild cases of acetonuria simply give sodium bicarbonate by the stomach. Bevan and Farill ("Jour. Am. Med. Assoc.," Sept. 20, 1905) reported one case and collected 27 from literature. In this series there were 2 recoveries. (On this subject see Lewis Beesly, in "Brit. Med. Jour.," May 19, 1906; J. A. Kelly, in "Annals of Surgery," Feb., 1905; A. D. Bevan and H. B. Farill, in "Jour. Am. Med. Assoc.," Sept. 20, 1905; Geo. E. Brewer, in "Transactions Am. Surg. Assoc.," vol. xx, 1902.)

Postanesthetic Paralysis or Narcosis Palsy.—Paralysis may arise during anesthesia as a result of cerebral hemorrhage or embolism.

It sometimes happens that when a person has come out of anesthesia a palsy of some part is found to exist, the condition being peripheral and not central in origin. Peripheral narcosis palsies are pressure palsies, although it is held by some that the anesthetic has a toxic influence which distinctly lowers the capacity of the nerves to sustain pressure. Certain it is that palsy sometimes follows what seems a degree of pressure inadequate to cause such a result. Narcosis palsies may be due to pressure of an extremity upon a tableedge or to pressure upon nerves by placing the patient in certain positions.\* When the Trendelenburg position has been employed, the flexures of the knees are in contact with the edge of the table, and paralysis of one or both external popliteal nerves may be induced. When the patient lies upon the side any nerve of the arm or forearm may suffer, but the circumflex and radial are most liable. When the arm is elevated to the side of the head or when it is drawn out strongly from the body the brachial plexus may be compressed by the head of the humerus (Braun, in "Deutsche Med. Woch.," 1894). When the arm is in external rotation and is drawn backward and outward, the median nerve is stretched, and when the forearm is flexed and supinated, the ulnar nerve is stretched (Braun, Ibid.). In most cases the paralysis involves muscles supplied by the brachial plexuses and is due to drawing the arm upward and backward over the head, a position which may squeeze the cords of the plexus between the collar-bone and the first rib. Garrigues shows that the plexus is particularly apt to be squeezed when it is stretched by the head being drawn to the opposite side or being allowed to fall back.† According to Büdinger the mounting up of the clavicle squeezes the plexus as its cords cross the first rib. This surgeon thinks that extreme abduction of the arm may squeeze the cords.

<sup>\*</sup> H. J. Garrigues, in Amer. Jour. Med. Sciences, Jan., 1897. † Amer. Jour. Med. Sciences, Jan., 1897.

Postanesthetic paralysis is most common in the arm, but may in the leg or face. The prognosis is good as a rule. Slight cases are recovered from; more serious cases, in which degeneration occurs, may not be recovered from for months. The treatment is that of any pressure palsy.

Primary Anesthesia.—Instruct the patient to count aloud and hold one arm above his head. Give the ether rapidly. In a short time he comes mixed in his count and his arm sways or drops to the side. There is now a period of insensibility to pain lasting only about half a mine inute, and during this period a minor operation can be performed. The patient quickly reacts from primary anesthesia without vomiting (Packard).

Mixtures.—Mixture of Ether and Chloroform.—This may be used in varying proportions. Hewitt employs 2 parts of chloroform to 3 parts

of ether.

Mixture of Alcohol and Chloroform.—All the chloroform mixtures produce the effects of chloroform, but we are giving the drug in an unknown amount. It was believed by Sansom, who devised this mixture, that the alcohol prevents concentration of chloroform-vapor by retarding evaporation. When used, I part of alcohol is added to 4 parts of chloroform.

Nitrous Oxid and Oxygen.—(See page 1206.)

A. C. E. Mixture.—This mixture is often valuable in cases in while ether cannot be given. It is composed of 1 part of alcohol, 2 parts of chloroform, and 3 parts of ether. Its action is supposed to be between that chloroform and ether. The objection to the A. C. E. mixture, as to a mixture, is that the materials do not evaporate in the ratio in which the are mixed, hence an uncertain amount of chloroform-vapor is being inhalm (Buxton). This mixture is given by some in a Junker and by others in an opinhaler. Plenty of air should be given with it. The anesthetic acts similar to chloroform.

Schleich's Mixture for General Anesthesia.—Schleich has recentl introduced a new anesthetic agent which he claims is safer than chloroforms This surgeon maintains that a material is safe as an anesthetic only when almost all of the amount taken in at an inspiration is expelled on expiration. The anesthetic is unsafe in direct proportion to the amount absorbed; and the lower the boiling-point of an anesthetic, the less is absorbed, hence an anesthetic agent, to be safe, should have a low boiling-point. Schleich makes three solutions. The first contains (by volume) 11 oz. of chloroform, to oz. of petroleum ether, and 6 oz. of sulphuric ether. The second contains 1½ oz. of chloroform, ½ oz. of petroleum ether, and 5 oz. of sulphuric ether. The third contains 1 oz. of chloroform, 1 oz. of petroleum ether, and 2 oz. of sulphuric ether. The anesthetic can be given on an open inhaler or a towel. The anesthetic state is quiet, reaction is rapid, and vomiting occurs in but half the cases. The superiority of this new anesthetic has not been proved. It sometimes causes dangerous symptoms, and has produced death. Some surgeons who formerly approved of it, have abandoned it. It will certainly not displace ether or chloroform. Petroleum ether has no anesthetic power and Meltzer shows that it is dangerous and tends to paralyze the repiratory muscles. Willy Meyer ("Med. Record," August 15, 1008) believes in the Schleich principle, but substitutes ethyl chlorid with a boiling-point of 59° F. for the petroleum ether. He uses 17 per cent, volume of ethyl chlorid with 83 per cent. volume of the molecular mixture of ether and chloroform.

Ethyl bromid is sometimes used for short operations. It is given while the patient is recumbent. The unconsciousness is obtained in from one to three minutes and is rapidly recovered from, and there is no after-sickness. The unconsciousness lasts about three minutes. Three drams are given to a child, and six drams to an adult. A towel is put over the face, and the entire amount to be given is poured on at once, and as soon as the patient is unconscious the towel is taken away and no more of the drug is given (Cumston). Even if consciousness is regained too quickly to suit the purposes of the surgeon, it is not safe to give more of the drug, a notable objection which chlorid of ethyl does not possess. Cases have been reported in which sudden death has followed the administration of this drug, and it should not be given if there is disease of the heart, lungs, or kidneys.\* Twenty-four deaths from bromid of ethyl are on record (Gaudiana). If it kills, it acts like chloroform. It may be given before ether to prevent unpleasant effects, but it is usually not considered proper to give it before chloroform. Zematski, however, has used it before chloroform in 2000 cases ("Vratch," August 25, 1901). There were recently two deaths from it in Philadelphia, neither of which was published. I never use it and regard it as unsafe.

Chlorid of ethyl is a rapid anesthetic and statistics imply that it is a safe one. My faith in it has been greatly shaken by knowledge of three unpublished deaths in Philadelphia. It was first used by Heyfelder in 1848. A committee of the British Medical Association condemned it in 1880. Carlson and Thiesing reintroduced it in 1895 (McCardie, in "Lancet," April 4, 1903). It may be sprayed upon a mask covered by six to eight layers of gauze, so that the drug does not evaporate too quickly in the air. Many anesthetists give it in a closed apparatus, the patient respiring into and from a rubber bag. The odor of the drug is agreeable. From 5 to 10 gm. of ethyl chlorid are given for a short operation if the mask is used. The patient must always be recumbent when taking it. The anesthetic state is induced, when the mask is used, in from two to three minutes, and as soon as it is obtained the patient is allowed to get air. If the closed inhaler is used unconsciousness is obtained more rapidly. The anesthetic condition lasts from one to three minutes, and it is recovered from rapidly, usually without vomiting or unpleasant after-effects. If the patient recovers too rapidly for the surgeon's purpose, more ethyl chlorid can be given. It is to be noted that complete muscular relaxation does not occur, in many cases the conjunctival reflex is not completely abolished, and often the pupils do not dilate. It has no superiority over nitrous oxid, except as to cost and portability, and sometimes it fails to produce complete unconsciousness. A large dose rapidly given is dangerous, as it may cause cessation of respiration and spasm of the diaphragm. A contraindication to its use is any respiratory obstruction. In many cases there is spasm of the masseters. Concentrated vapor administered for a considerable time lowers the blood-pressure, induces cyanosis and asphyxia, and would eventually cause death by respiratory failure (McCardie, in "Lancet," April 4, 1903). Lotheisser, in a study of 2500 cases of anesthesia by this agent, reports 1 death. Ware collected 12,436 cases with 1 death ("Jour. Am. Med. Assoc.," Nov. 8, 1902). Seitz, of Konstanz, collected 16,000 cases with 1 death. It is perhaps safer than chloroform, not nearly so safe as nitrous oxid, and not so safe as

<sup>\*</sup>See Cumston, in Boston Med. and Surg. Jour., Dec. 20, 1894.

ether. The drug is used only for a brief operation or examination. It can be given to infants a few days old with reasonable safety and it has been administered many times to the aged. When it kills, it acts in a similar manner to chloroform. I have often given it before ether to prevent unpleasant symptoms and to hasten the advent of anesthesia, but it must never be given before chloroform. Of late I have practically ceased to use it.

Nitrous oxid gas may be used to obtain anesthesia for brief operations. It is contraindicated when vascular degeneration exists, because apoplexy may follow its administration. It should never be given when the airchannel is narrowed, as in Ludwig's angina, abscess in or below the tongue, and thyroid enlargement (F. W. Hewitt, in "Lancet," July 20, 27, and



Fig. 706.-Hewitt's nitrous oxid apparatus.

August 10, 1907). This gas stored in steel cylinders, in which it is liquefied. The gas is passed into a rubber bag (Fig. 706), and is given to the patient by means of a tube and a mouth-mask, a wedge being placed between the patient's molar teeth, and the nostrils being closed by the anesthetist's fingers. The wedge must be held by a string, so that it cannot be swallowed. The patient becomes unconscious in about one minute, and we know the patient is anesthetized by the stertor and cyanosis and the insensitiveness Watch the of the conjunctivæ. pulse, and if it flags, at once suspend the administration. The phenomena are asphyxial, stertorous respiration, cyanosis, and even convulsions, dilatation of the pupils, rapidity of the heart, and swelling of the tongue.\* It is sometimes useful to give nitrous oxid first and follow this with ether (page 1208). By this method the patient is ancethetized rapidly and pleasantly with the nitrous oxid, and the anesthein is maintained by the ether.

It was formerly taught that nitrous oxid necessarily produces cyanosis, because the gas can only cause and thesia by partially asphyxiating the patient. We know this is untrue,

because if nitrous oxid is mixed with oxygen or atmospheric air anesthesis is obtained without cyanosis. Nitrous oxid is a genuine anesthetic agent. If a prolonged administration of nitrous oxid is desired, pure nitrous oxid can be

<sup>\*</sup> See Hewitt, Brit. Med. Jour., Feb. 18, 1899.

given, a breath of fresh air being allowed from time to time. By this method Preston has anesthetized many patients, the duration of the anesthesia being from ten to fifty minutes. A better plan is to give nitrous oxid and oxygen. I am satisfied that this combination does not occupy the place in surgery its merits entitle it to. One reason is the absolute necessity of having a specially skilled administrator. A trouble frequently encountered is persistent rigidity. This can often be prevented by a preliminary dose of morphin. Postanes-



Fig. 707.-Hewitt's nitrous oxid and oxygen apparatus.

thetic vomiting is rare (Teter, in Thirteen Thousand Administrations of Nitrous Oxid with Oxygen, "Jour. Am. Med. Assoc.," August 7, 1909). Hewitt formulates the following views as to the use of oxygen and nitrous oxid.\*

"In order to obtain the best form of anesthesia oxygen should be administered with nitrous oxid by means of a regulating apparatus (Fig. 707), the percentage of the former gas being progressively increased from 2 to 3 per cent. at the commencement of the administration to 7, 8, 9, or 10 per

<sup>\*</sup> Brit. Med. Jour., Feb. 18, 1899.

cent., according to the circumstances of the case. The longer the administration lasts, the greater may be the percentage of oxygen admitted.

"The next best results to those obtainable by means of a regulating apparatus for nitrous oxid and oxygen are to be secured by administering certain constant mixtures of these two gases. Mixtures containing 5, 6, or 7 per cent. of oxgyen are best for adult males; and mixtures containing 7, 8, or 9 per cent. are best for females and children. The next best results to those last mentioned are to be obtained by means of mixtures of nitrous oxid and air, from 14 to 18 per cent. of the latter being advisable in anesthetizing men, and from 18 to 22 per cent. in anesthetizing women and children."

Bichlorid of Methylene.—The composition of the so-called bichlorid of methylene is a matter of dispute. Some high authorities believe it to be a mixture of methyl alcohol and chloroform. It rapidly produces unconsciousness, and the patient returns quickly to consciousness when the administration is suspended. Some surgeons have thought highly of it, and claim that it is pleasant, safe, and is not followed by vomiting as often as is chloroform. The weight of opinion is that it is dangerous, death being similar to death from chloroform. It is given by means of a Junker apparatus.

Anesthetic Successions.—Bromid of Ethyl Followed by Chloroform or Ether.—(See page 1205.)

Chlorid of Ethyl Followed by Ether.—(See page 1205.)

Chloroform Followed by Ether.—Chloroform is sometimes given until the sensation becomes more or less obtunded, when ether is substituted. This is done to save the patient from the unpleasant sensations of etherization. It is a practice not to be commended, because it is precisely in the

beginning that chloroformization is most dangerous.

Ether Followed by Chloroform.—When the patient cannot be relaxed or rendered unconscious by ether, or when some other complication develops, it is common practice to suspend ether and substitute chloroform. If the change is made, chloroform should be given cautiously. A large quantity should never be poured upon the inhaler at one time. The change should never be made when the patient is struggling, because the deep respirations which attend or follow struggling may lead to the rapid inhalation of a dangerous dose of chloroform-vapor. Further, as Hewitt points out, when the patient is deeply under the influence of ether, the change should not be made unless it is imperatively necessary.

Nitrous Oxid Gas Followed by Ether (Gas and Ether).—This very valuable method was suggested by Clover. I have used it repeatedly with great satisfaction. The patient is made unconscious by nitrous oxid and is kept unconscious by ether. Thus are avoided excitement, struggling, choking, and the very unpleasant sensations induced by ether. It lessens the amount of time requisite to obtain anesthesia and lessens the amount of ether used. More important even than this, the method is safe. It is more satisfactory in women and children than in men. In very muscular men and in very stout elderly men it should not be used. In many cases nitrous oxid causes a flow of mucus from the respiratory tract. Because of the frequency of this happening it is wise to precede gas and ether anesthesia twenty minutes by a

natic injection of morphin and atropin (Van Kaathoven, in "Annals ry," Sept., 1908), or, as I usually prefer, of atropin alone. Many first anesthetize with nitrous oxid, using an ordinary dental apparathen give ether on an ordinary inhaler. The anesthetist must bear that ether must be given gradually, not suddenly poured on in large Others prefer to use a combined gas-and-ether inhaler. Hewitt cribes the administration by means of Clover's portable ether-inhaler th a stop-cock and a detachable gas-bag ("Anesthetics and their ration"):

The face-piece with the charged ether chamber is then applied a expiration. Air will be breathed backward and forward. When ration is seen to be proceeding freely, and the face-piece fits well, ged gas-bag is attached to the ether chamber. Air will still be but not through the valves of the special stop-cock. When the e heard to be working properly, 'gas' is turned on, and is likewise through the valves. Three or four respirations (or about one-half ntents of the bag) are allowed to escape. The valve action is now by turning the tap at the upper part of the stop-cock. At the same at which the patient begins to breathe 'gas' backward and fore rotation of the ether chambers, for the addition of ether-vapor e commenced. The administrator will, in fact, find that he can, seconds from the commencement of the administration, rotate the umber as far as '1' or '1½.' Should swallowing or coughing

must rotate more slowly. Respiration omes deep and regular, and more and more y be admitted. At about this juncture, if ratus has been fitting the face well, signs of xid narcosis may appear, especially in those quickly affected by this gas. Should jerky or 'jactitation' arise, one full inspiration v be admitted at the air-tap. It should be red, however, that in giving 'gas and ether' ethod, the object is to just steer clear of the d 'stertor' of nitrous oxid narcosis, and to but increasingly mix ether with the gas. nuscular and vigorous subjects, the quantity pove mentioned will be found to be, as a ale, insufficient to lead to the usual signs of ous oxid anesthesia. The rotation of the mber should be continued till the indicator '2,' '3,' or 'F.'

mistake that is most commonly made is lmitting air too soon. Should air be given e first half or three-quarters of a minute, the ill partially come round, hold his breath, set and give a good deal of trouble. Duskiness

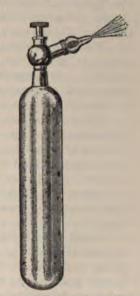


Fig. 708.—Gebauer's ethylchlorid tube.

atures must be expected. Speaking generally, air should not be intil the patient is stertorous, when one breath may be given. In

this manner the patient will continue breathing a mixture of nitrous ether, and air, till the usual signs of deep ether anesthesia appear, when the gas-bag may be detached, and the little bag ordinarily used with Clause's inhaler substituted."

Hewitt prefers to use a modified Clover's inhaler, which permits introduction of ether after the inhalation of nitrous oxid has begun.

Scopolamin-morphin Anesthesia.—This method has been enthan tically praised and I used it with satisfaction in a number of cases, but I grown afraid of it. In a patient in the Jefferson Hospital dangerous symp spiraarose after a dose of gr.  $\frac{1}{100}$  of scopolamin. Ely records a death from res o of tory failure two hours after the administration of gr. 1 of morphin and gr. 1 have scopolamin ("New York Med. Jour.," Oct. 20, 1906). Fifteen deaths been reported as following its use and there are beyond doubt unreported c Four deaths in 2400 cases were certainly directly due to it (H. J. Whita =acre. I that in "New York Med. Jour.," March 31, 1906). It has even been stated the death-rate is 1 in 100 ("Semaine Medicale," Jan. 11, 1905). Scopola is chemically identical with hyoscin and must never be used unless fresh it decomposes in air and light. If given without morphin, it is ineffic-Large doses are certainly dangerous, and the combination should nevegiven in sufficient amount to induce anesthesia unaided. If used at a should only be as an aid to local anesthesia or to general anesthesia by ether chloroform. I have used it as an aid to local anesthesia in 6 goiter operatiand in 2 cases of removal of the Gasserian ganglion. It should not be in heart disease (Hayem); in persons under sixteen or over sixty (Kom in any one with a tendency to pulmonary edema or with any acute condiof the throat which interferes with respiration (A. C. Wood, in "American American Control of the throat which interferes with respiration (A. C. Wood, in "American Control of the throat which interferes with respiration (A. C. Wood, in "American Control of the throat which interferes with respiration (A. C. Wood, in "American Control of the throat which interferes with respiration (A. C. Wood, in "American Control of the throat which interferes with respiration (A. C. Wood, in "American Control of the throat which interferes with respiration (A. C. Wood, in "American Control of the throat which interferes with respiration (A. C. Wood, in "American Control of the throat which interferes with respiration (A. C. Wood, in "American Control of the throat which interferes with the throat which with the throat which interferes with the throat which wit Medicine," Nov. 11, 1905).

It produces a drowsy, heavy state or actual sleep, and the patient can be kept unconscious with an extremely small quantity of ether or chloroform. For five or six hours after the operation the sleep continues, and in most causes

there is not post-operative vomiting.

If it is used, a mixture is freshly made containing gr.  $\frac{1}{100}$  of scopolar and gr.  $\frac{1}{6}$  of morphin, and this is given hypodermatically one-half an hobefore the operation. During the operation the sleep may be maintain by ether or chloroform. If symptoms of poisoning occur, artificial respiration and oxygen inhalations may be required, external heat is needed, and nitroglycerin, strychnin, or caffein are given.

I agree with Kochmann that we are not as yet justified in recommending this method of anesthesia ("Münchener medizinische Wochenschrift,"

1905, No. 17).

Local Anesthesia.—In every case requiring operation we should inquire whether local anesthesia can be used instead of general anesthesia. Many really extensive operations can be done under it and its field has been greatly broadened by the knowledge that viscera innervated by purely visceral nerves are insensitive and sensation exists only in those which receive branches from the somatic nerves (K. G. Lennander, in "Mittheilungen aus dem Grenzgebieten der Medicin und Chirurgie," Bd. x, Heft 1 and 2, 1902). Lennander shows that the parietal peritoneum is sensitive to pain, but not to touch—that the intestine, stomach, edge of liver, mesentery, gall-bladder,

urinary bladder, kidney parenchyma, lung, anterior wall of the trachea, testicle, and epididymis are insensitive, though the coverings of the testicle and epididymis are sensitive. My experience is that the viscera may be cut, sutured, and handled without any severe pain if they are not pulled upon. In removing an appendix the only pain felt will be when the meso-appendix is pulled upon or adhesions to the parietal peritoneum are separated. Baldy recently affirmed Lennander's views ("Surg., Gynecol., and Obstet.," May, 1909). The advantages of operation under local anesthesia are freedom from the danger of anesthetic accidents, blood changes, and postanesthetic discomforts and dangers. The disadvantage is the knowledge of the patient as to what is taking place. He may become alarmed and turbulent and may thus interfere with a necessary procedure at a vital moment. I have operated under local anesthesia with satisfaction in the following cases: Tracheotomy, rib resection, goiter, iliac colostomy, typhoid perforation, abscess of the lung, gangrenous appendicitis, radical cure of hernia, strangulated hernia, suprapubic cystotomy, extirpation of the external carotid artery (Dawbarn's operation), and ligation of the femoral artery. There are many methods of local anesthesia.

Freezing.—Ice and salt may be used. Take one-quarter of a pound of ice, wrap it in a towel, and break it into fine bits; add one-eighth of a pound of salt; then place the mixture in a gauze bag and lay it upon the part. The surface becomes pallid and numb, and in about fifteen minutes decidedly analgesic. A spray of rhigolene freezes a part in about ten seconds. It is highly inflammable. Ether-spray anesthesia was suggested by Benjamin Ward Richardson. Chlorid of ethyl comes in glass or metal tubes (Fig. 708). Remove the cap from the tip of the tube and hold the bulb in the palm: the warmth of the hand causes the fluid to spray out. Hold the tube some little distance from the part, and let the fine spray strike the surface. The skin blanches and whitens, and is ready for the operation in about thirty seconds.

Hypodermatic Injection of Cocain Hydrochlorate.—Always bear in mind that cocain is sometimes a decidedly dangerous agent. There are on record fourteen deaths from cocain (Reclus). The urethra is a particularly dangerous region, and so is the face. Never use more than two-thirds of a grain upon a mucous surface, and never inject hypodermatically more than onethird of a grain, and be sure never to inject the drug into a vein. Mild cases of cocain-poisoning are characterized by great tremor, restlessness, pallor, dry mouth, talkativeness, and weak pulse. In severe cases there is syncope or delirium. Death may arise from paralysis or from fixation of the respiratory muscles (Mosso). Cases with a tendency to respiratory failure require the hypodermatic injection of strychnin. In cases with tetanic rigidity of muscles give hypodermatic injections of nitroglycerin, or inhalations of the nitrite of amyl. In cases marked by delirium, if the circulation is good, give hyoscin. In any case give stimulants, employ a catheter, and favor diuresis. Cocainpoisoning is always followed by a wakeful night. Cocain should not be used if the kidneys are inefficient. In using cocain try to prevent poisoning. Because of the dangers inherent in cocain, have the patient recumbent. One minute before giving the cocain administer hypodermatically one drop of a 1 per cent. solution of nitroglycerin and repeat the dose once during the operation. In operating on a finger, after making the part anemic, tie a tube around the root of the

digit before injecting cocain, and after the operation gradually loosen the A hot solution of cocain is more efficient than a cold solution (T. Costa); hot solutions can be used in much less strength and are safer. The meth injection is as follows: A sharp needle is held at an angle of forty-five de to the surface, and is pushed into the Malpighian layer. One or two minitants of a 2 per cent, solution are forced into the Malpighian layer, and a whitelevation forms. The needle is withdrawn, at the margin of the whe reinserted, and more fluid is introduced, and so on until the region to be operated upon has been injected. After waiting five minutes the operation is begun. If, after cutting the skin, it is necessary to cut the subcutanteous tissue, pour a few drops of a 1 per cent, solution into the wound from to time. After the completion of the operation, if a rubber band was use it is loosened for a few seconds, tightened for a few minutes, again loose and readjusted, and so on several times (Wyeth). In this way only a small quantity of cocain is admitted into the circulation at one time, and to stock symptoms are prevented. For operations upon the eye a 1 to 4 per c solution is employed; a drop of fluid is instilled every ten minutes until the drops have been given. Rarely use over a 10 per cent. solution ation mucous membrane, although in laryngeal operations a 20 per cent. solu may be required. For the nasal mucous membrane a bit of wool soaked 5 per cent. solution is inserted or a spray of 4 per cent. solution is three from an atomizer into the nostrils. In the rectum, vulva, vagina, and uterus use a 5 per cent. solution; in the urethra, a 4 per cent. solution, and in the bl der, a 2 per cent. solution.

Cocainization of a Nerve-trunk.—Krogius has pointed out that cocain is injected into the tissue about a nerve-trunk anesthesia will follow in the area supplied by the nerve. The anesthesia will be produced in minutes, and will last fifteen minutes. If cocain is injected about the roof the finger, all of the tissues of the digit will become insensitive. Injection over both supra-orbital notches renders the middle of the forehead insensitive. Injection over the ulnar nerve causes complete anesthesia of its trajector.

This plan is extensively used in Helsingfors.

It has been demonstrated by Crile ("Jour. Amer. Med. Assoc.," Fel22, 1902) that the injection of cocain into a nerve-trunk interposes an absolut
block to the transmission of afferent and efferent impulses and greatly lessen
operative shock. In 5 cases he employed this method to secure anesthesis
for amputation of the leg, and 4 of the patients did not know that any operation was being performed.

Eucain hydrochlorate ( $\beta$ -eucain) is far safer than cocain, and in most cases is to be preferred to it. It is injected in the strength of from 2 to 5 per cent. It can be boiled without destroying its properties, and hence can be readily rendered sterile. It occasionally, though rarely, happens that the injection of eucain causes sloughing, especially at the extremities, in fatty tissue, in tendon-sheaths, and in bursæ. It can be used on mucous membranes.

Stovain.—This agent is a new local anesthetic introduced by Fourneau. It is as powerfully analgesic as cocain, is only one-third as toxic, and is slightly germicidal. It is dissolved in cold water, or salt solution and a solution used of the strength of 0.5 per cent. Adrenalin can be given with it (see Sonnenburg, in "Deutsche medicinische Wochenschrift," March, 1905).

Infiltration-anesthesia was devised by Schleich, of Leipsic, who was dissatisfied with cocain, because it is not safe and sometimes fails to produce complete local anesthesia, owing to want of thorough diffusion. He found that salt solution (0.2 per cent.), if injected into uninflamed parts, produced anesthesia. To obtain this anesthesia the part must be distended by wide infiltration. If minute quantities of cocain, morphin, and carbolic acid are added to the solution, the anesthesia becomes more thorough and more prolonged, and can be obtained even in inflamed areas.

Schleich uses three solutions:

No. 1, a strong solution; which is used in inflamed areas: cocain hydrochlorate, gr. iij; morphin hydrochlorate, gr.  $\frac{2}{5}$ ; sodium chlorid, gr. iij; disilled sterile water,  $3iij_{5}^{2}$ ; phenol (5 per cent.), 2 drops.

No. 2, medium solution, which is employed in most cases: cocain hydrochlorate, gr. iss; morphin hydrochlorate, gr.  $\frac{2}{6}$ ; sodium chlorid, gr. iij; disilled sterile water,  $\frac{\pi}{5}$  iij $\frac{2}{6}$ ; phenol (5 per cent.), 2 drops.

No. 3 is the weak solution used to infiltrate extensive areas: cocain hydrohlorate, gr.  $\frac{1}{6}$ ; morphin hydrochlorate, gr.  $\frac{2}{5}$ ; sodium chlorid, gr. iij; dis-

illed sterile water, 3iij2; phenol (5 per cent.), 2 drops.

The injections are begun in the skin, not under it (Fig. 709), and are nade one after another until the area to be operated upon is surrounded bove, below, and on all sides with Schleich's solution. At each infiltrated area a wheal forms in the skin. This infiltration can be made painlessly by touching with pure carbolic acid the point where the needle is to be inserted, or by freezing this spot with ethyl chlorid. After infiltration of the skin the surgeon waits ten or fifteen minutes and then operates, incision is made, and when deeper tissues are reached, they are infiltrated before incising them. If a nerve comes in sight, touch it with a drop of pure carbolic acid. Van Hook says that the anesthesia obtained by this method is due to artificial ischemia, pressure upon the tissues, the direct action of the drugs, and the lowered temperature.\* The method is very efficient, and can be used for operations of considerable magnitude, Matas uses a special apparatus to infiltrate the tissues. The fluid is driven by compressed air, and wide-spread or "massive" infiltration is produced. The addition of adrenalin chlorid to the cocain solution is an advantage, as it retards the circulation and hence favors analgesia and lessens bleeding during the operation. I do not believe that adrenalin in any way modifies the toxic action of cocain—in fact, Berry ("Am. Jour. Med. Sciences," Nov., 1905) seems to prove that it actually increases it. A satisfactory fluid for infiltration is 1 part of a 1:1000 solution of adrenalin chlorid and 9 parts of a 0.5 per cent. solution of cocain (Gangitans, in "Riforma Medica," Sept. 9, 1903). Eucain and adrenalin are preferred by some. Barker uses distilled water, 100 gm.; pure sodium chlorid, 0.8 gm.; \(\beta\)-eucain, 0.2 gm.; chlorid of adrenalin, 0.001 gm. After injecting this fluid the surgeon waits for twenty minutes before operating,

Bier's Intravenous Method of Local Anesthesia.—This plan was described by Bier at the German Surgical Congress of 1908. It permits of serious operations upon the limbs, operations for which ordinary methods of local anesthesia would prove quite inefficient. Suppose the surgeon intended

to resect an elbow-joint. The Esmarch bandage is used to make the limb bloodless. A thin soft-rubber band is applied many times around the armabore the elbow, and a like band is applied below the elbow. The anesthetic is injected into a superficial vein (basilic or the cephalic). The vein is exposed, the syringe of the canula is introduced, and ligatures are used as though we were going to give an ordinary intravenous injection of salt solution, except that the canula is pointed to the periphery. The fluid used is a .25 or .5 per cent, solution of novocain. The syringe, containing 50 cc. of fluid, forces the solution downward into the veins and the limb swells.

If the stronger solution is used, 50 cc. are enough; if the weaker solution is used, 100 cc. will be required. If resecting the knee the injection should be made into the internal saphenous vein and twice the amount would be necessary as advised for the elbow.

After injecting the strong solution operation may be begun at once. After injecting the weak solution we should wait ten minutes. The analgesia is entirely satisfactory and passes away as soon as the band is removed. Sometimes motor palsy occurs as well as sensory paralysis. When the operation has been completed, wash out the vein with salt solution in order to prevent toxic effects.

Anesthesia by Infiltration with Sterile Water.—When the fisues are well infiltrated with warm or cold sterile water, anesthesia ensues promptly. I have not found it as complete as when cocain or eucain is employed, even when a considerable amount of fluid is introduced. Gant uses it in rectal operations and commends it strongly ("New York and Phila. Med. Jour.,"

Jan. 28, 1904).

Spinal Analgesia.- J. Leonard Corning in 1885 discovered that comin injected between the spines of the eleventh and twelfth dorsal vertebræ produces analgesia of the lower limbs ("N. Y. Med. Jour.," Oct. 31, 1885). From this observation spinal anesthesia springs. Bier produced complete anesthesia of the entire body except the head by the injection of a small amount of cocain into the subarachnoid space of the spinal cord. A solution of cocain of a strength of from 0.5 per cent. to 1 per cent. is used by some, but cocain cannot be boiled without impairment of its anesthetic power, and carbolic acid must be added to it in small amount. Hence cocain so prepared is not certainly sterile, and the carbolic acid added may induce harmful symptoms. (See Neugebauer, in "Wien. klin. Woch.," 1901, Nos. 50, 54, 52.) Some surgeons use a solution of eucain which can be boiled, but it is not so rapid and certain as cocain. Some use tropacocain (Illwica). A solution of this drug can be boiled, is less poisonous than cocain, and some what slower in action. Experimenters tell us that gr. ss to gr. iss may be given, but it is not wise to give over 0.5 grain. I have used stovain in 3 number of cases. It may be combined with adrenalin if this is desired. The dose is 5 to 10 gm. The analgesia lasts from one-half an hour to an hour of more, and was followed in my cases by retention of urine. Some have used novocain, alone or combined with adrenalin.

The best plan is that of A. W. Morton. He takes chemically pure crystalline hydrochlorate of cocain, places it for fifteen minutes in a dry temperature of 300° F., and puts it in sterile tubes until wanted. The dose depends upon the locality in which we wish to induce analgesia, and varies between 0.3

and 0.5 gr. The required dose is placed in the barrel of the sterile syringe and is dissolved in cerebrospinal fluid drawn into the syringe for that purpose. The syringe should be of glass, so that it can be boiled. The concave portion of the needle should be dull, so that a plug of skin will not be cut out and obstruct the needle (A. W. Morton, in "Jour. Amer. Med. Assoc.," Nov. 8, 1902). The patient lies upon his side with the back curved. The back has been previously sterilized. The dressings are removed and the region to be punctured is resterilized. The spines of the third and fourth lumbar vertebræ are located, and the needle is entered in the mid-line beneath the spine of the third or fourth lumbar vertebra and is pointed upward and forward. The surgeon determines that he has punctured the subarachnoid space by essened resistance and the appearance of fluid at the needle-opening. The wringe, with a closed piston, contains 0.3 gr. of sterile cocain. It is attached o the needle; the piston is withdrawn until the syringe is half full of cereprospinal fluid. When the cocain is dissolved, the solution is slowly injected, he needle is withdrawn, and the puncture is sealed with collodion.

The anal region becomes anesthetic in from one to two minutes, the ower extremities in from three to six minutes, and the upper extremities n from fifteen to thirty minutes. The anesthetic condition lasts from one o three hours, or even longer, and is due to the contact of cocain with the nerve-roots (A. W. Morton, "Jour. Amer. Med. Assoc.," Nov. 8, 1902).

In performing the operation care must be taken to prevent the escape of cerebrospinal fluid.

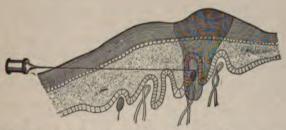


Fig. 709.—The syringe-point stops at the papillary layer, and the fluid lodges in the skin itself (Van Hook).

After cocainization of the spinal cord surgical operations can be performed on many regions without causing pain. Among the operations which have been performed are resection of the knee, resection of the ankle, osteotomy (Bier), amputation of the leg (Lower), and hysterectomy (Tuffier).

Spinal analgesia is not growing in popularity. It is regarded by most surgeons as a method to be used in exceptional cases. It should never be used as a routine procedure, and it will not displace ether or chloroform. By it analgesia can usually be secured. A. W. Morton ("Jour. Amer. Med. Assoc.," Nov. 8, 1902) has used it 673 times without a failure, and 60 of these operations were above the diaphragm. If we desire to obtain analgesia of the upper portion of the body the patient must be placed in the Trendelenburg position after the fluid has been injected. Most operators have had failures, especially above the diaphragm. In Sonnenburg's 1117 cases there were 78

utter failures ("Jour. de Chir.," Oct., 1908). Bier says that failures occur in 4 per cent. of cases; Moynihan says in 14 per cent.; Leguen says in one-seventh of the cases. In Barker's last 100 cases it failed 3 times. No one should attempt it who is not well trained in aseptic methods, because infection of the cord or its membranes will prove fatal. Untoward effects are common,

and they may arise during or after the operation.

Sonnenburg had them in 193 out of 1117 cases. Among the untoward effects reported are grave collapse, temporary paralysis of the abducens nerve, of the facial nerve, of the hypoglossal nerve, meningitis, retention of urine, chills, elevation of temperature, incontinence of urine, persistent paraplegia, pain in the back and legs, perhaps lasting for months, nausea and vomiting during and after the operation, sweating, overaction of the heart, dimness of vision, cramps in the limbs, dyspnea, violent headache, involuntary evacuation of feces, and cardiac overaction. Many of the immediate symptoms are probably due to the absorption of the drug injected. The headache is due to tension and is relieved when some cerebrospinal fluid is withdrawn by lumbar puncture.

Whether or not permanent harm ever comes to the cord is not certain. Bristow ("Brooklyn Med. Jour.," 1902, xvi, page 410) reports the case of a man, fifty-five years of age, on whom he operated for hemorrhoids after spinal cocainization. An examination one month later indicated degeneration of the posterior and lateral columns of the cord (spastic lower extremities, ataxic gait, increased knee-jerks, ankle-clonus, and inability to retain urine). Marx ("New York Med. Record," Dec. 22, 1900) states that one case in his experience, after cocainization of the spinal cord, developed typical locomotor ataxia. Dandois ("Jour. de Chir. Brux.," April-May, 1901) reports a case upon which he had operated for traumatic rupture of the urethra. Spinal cocainization was employed. Paraplegia developed and lasted two months. Several cases of hemorrhage into the subarachnoid space are on record. Leguen states that persistent paraplegia and persistent incontinence of urine may arise ("Rev. de Chir.," Oct., 1908).

Is there any danger of death from spinal analgesia? If the operation is not performed with scrupulous aseptic care it is very dangerous. Even when performed by the best surgeons death may occur. Tuffier places the mortality at 3 in 2000, but excludes from consideration 3 deaths ("La Presse Médicale," vol. lv, 1901, page 190). Reclus finds 6 deaths in less than 2000 cases (Address before the Paris Academie de Médicine, March 19, 1901). Hahn, in 1708 cases collected from literature, found 8 deaths ("Mith. a. d. Grenzgeb. d. Med. u. Chir.," 1900, iii, 337). The mortality is usually supposed to be about 3 in every 1000 cases. Wm. N. Perkins ("New Orleans Med. Jour.," Jan.-Sept., 1902) collected 2345 cases with 16 deaths or 1 death in 146 administrations. Strauss's table shows 46 deaths in 22,717 cases (quoted

by Hardonin, in "Archiv. Générale de Chir.," August, 1908).

Cocain seems to act like a toxin on the pia and arachnoid. Examination of fluid withdrawn after the performance of cocainization shows that it contains polymorphic leukocytes (Ravant and Aubourg, in "Gaz. Hebd. de Médet de Chir.," June 27, 1901).

In a case in which, because of heart disease, pulmonary disease, kidney disease, or some other condition in which a general anesthetic is inadmissible.

spinal cocainization is justifiable. It should be reserved exclusively for cases in which other forms of anesthesia are positively contraindicated. The method should not be employed on those under fifteen or on the subjects of central nervous disease.

A solution of Epsom salts has been used by Blake, Haubold, and Willy Meyer. It was discovered (Meltzer and Auer, "Am. Med.," Nov. 25, 1905) that subcutaneous injections of salts of magnesium produce local anesthesia. The same investigators later pointed out (S. J. Meltzer, "Med. Record," Dec. 16, 1905) that subarachnoid spinal injections produce wide-spread and complete anesthesia. A 25 per cent. solution is used and 1 cc. of this is given for every 25 pounds of body weight. After a wait of three or four hours the drug causes paralysis and analgesia of the legs and pelvic region. Sensation and motion do not return for eight to fourteen hours. Retention of urine may last two days. The pulse and blood-pressure are unaffected, but the respiration is slowed. Large doses would endanger life by respiratory arrest. In view of the fact that in some cases the effect of the drug is inordinately prolonged, it is wise, when the operation is completed, to puncture the theca of the cord again and wash it out with salt solution.

## XXX. BURNS AND SCALDS.

Burns and scalds are injuries due to the action of caloric. Scalds are due to heated fluids or vapors. There is no true pathological difference between burns and scalds. Dupuytren classifies burns into six degrees, as follows: (1) Characterized by erythema; (2) characterized by dermatitis with the formation of vesicles; (3) characterized by partial destruction of the skin, which structure is not, however, entirely burned through; (4) characterized by destruction of the skin to the subcutaneous tissue; (5) characterized by destruction of all superficial structures and of part of the muscular layer; (6) characterized by "carbonization" of the whole thickness of the muscles.

The symptoms of a severe burn are local and constitutional. Local symptoms are pain and inflammation, which very in nature, in intensity, or in degree according to the extent of tissue-damage. Constitutional symptoms are very weak pulse, shallow respiration, and subnormal temperature—in other words, the condition of shock exists. The patient may die without reacting from shock, but in most cases there is reaction, followed by a severe reactionary fever, with a strong tendency to congestion of internal parts. During the existence of fever there may be vomiting, diarrhea, hemoglobinuria, albuminuria, and enlargement of the liver, spleen, lymph-glands, and tonsils. Marked blood changes follow burns (see "Clinical Hematology," by J. C. DaCosta, Jr.). There is a marked and rapid increase in red blood-cells (polycythemia). This is due in part to venous stasis and in part to loss of blood plasma. Leukocytosis is rapid and pronounced and there is a notable increase in blood plaques.

The blood has a marked disposition to clot, and clots may damage various structures or organs. Further, the altered blood damages the organs of excretion, and the liver and kidneys may cease to perform their functions properly. After a severe burn there are imperfect oxygenation and a ten-

dency to universal fatty degeneration. The syr designated as prostration, reaction, and suppurati eight hours after a burn there are congestion in a severe pain, and possibly internal congestions. possibly toxic delirium or convulsions. From th end of the eighth or ninth day there are severe inflaformation of sloughs, and a strong tendency to in head burns, of the lungs in chest burns, of the abd burns, and of duodenal inflammation in any burn unusual cases cause Curling's ulcer of the du Curling's ulcer are possibly due, as Wm. Hunter s become irritant by the excretion in it of toxic mat Treatment," by W. Watson Cheyne and F. F. B or ninth day the sloughs separate from the burne The raw surface is slow to heal, hemorrhages may apt to be exuberant and edematous, and the sca often produce hideous or disabling deformity. If surface is badly burned, death will almost certainly two days. The danger of a burn depends upon i situation. Burning of a large area superficially than burning a small area deeply. Burns of the ex ous as are burns of the head, chest, or abdomen. positively not due to loss of body-heat in the bur produced by autointoxication with retained bodyture produces blood-changes-viz., disintegration bosis may occur, and irritation of the kidneys and "products of corpuscular degeneration."\*

The blood of burned animals contains toxins the urine (Reis). It seems probable that the co death, if it occurs, are due partly to corpuscular to the absorption of toxic matter from the seat of been formed by the action of heat on the bodynot infrequent. Death may be directly due to sho to embolism or thrombosis, to congestion of the or to Curling's ulcer of the duodenum.

Treatment.—The local treatment of slight parts frequently with a saturated solution of t a 1:8 solution of phénol sodique. In burns of n of zinc ointment with iodoform, though not a dressing.

If a large surface is burned, remove the clothing applying dressings, give a hypodermatic injectic stimulants, and if the patient has a chill, place his ordinary means to secure reaction from shock. I burn aseptically, anesthetize the patient, spray oxid of hydrogen, irrigate it with a solution of locotton, dust with Senn's powder (three parts of b salicylic acid), and dress with salicylated cotton

<sup>\*</sup> Bardeen, in Johns Hopkins Hospital Bull

than iodoform. Iodoform may allay pain, but is apt to produce dermatitis. Change the dressing no oftener than is required, and at each change proceed as above described, although it will not be necessary to anesthetize. Peroxid of hydrogen softens and loosens the dressings, and they can be readily removed. The custom in the Jefferson Medical College Hospital is to give morphin and stimulants, to cut away the clothing, to wrap the unburned parts with blankets, and place about them cans or bags of hot water. The burned region is sprayed with peroxid of hydrogen contained in an atomizer, and irrigated with salt solution. Portions of epidermis which remain are retained. Any blisters are opened with a sterile needle, and the part is dressed with several layers of sterile lint or tarlatan soaked in normal salt solution, and the dressing is kept moist. During the second or inflammatory stage use stimulants and concentrated food, allay pain by opium or morphin, favor elimination by the skin, bowels, and kidneys, and combat any tendency to internal congestion or inflammation. In very extensive burns complete and continuous immersion of the part in warm salt solution is an excellent treatment.

The picric acid treatment, first suggested by Thiery, has many advocates. It greatly mitigates the pain. It is used early only in limited burns of the first and second degrees, but it can be employed in late stages of deep burns to stimulate the formation of epidermis. If used early in a large or a deep burn, it may poison the patient. It may poison a child when used upon a burn of the second degree. A case was reported by Dr. J. Stuart Rose ("Scottish Med. and Surg. Jour.," Dec., 1903), occurring in a boy of nine, who was treated with picric acid for a scald of the first degree, there being only one or two small blisters in addition to the redness. Ointment of picric acid was used (3ss to an ounce of vaselin). Symptoms were noted three days after beginning the treatment. The symptoms are dark-colored urine (carboluria), albuminuria, marked yellowness of the skin, yellowness perhaps of hair at the scalp margins, diarrhea, and elevated temperature. Rose considers a r per cent. solution safe. It is applied as follows: The part should be disinfected, gauze saturated with a 1 per cent. watery solution of picric acid should be laid upon the burned area, and be covered with absorbent cotton and a bandage. This dressing is not changed for three to five days, and the next dressing can be left in place until the burn is healed. D'Arcy Power has carefully studied the real status of picric acid as a remedy for burns, and some of his conclusions have been set forth above.

Périer dresses a burn with a tarlatan compress, folded six times and soaked in the following solution: boric acid, 3 iiss; antipyrin, 3 iss; sterile water, 3 viij. The following ointment is used by Reclus: iodoform, gr. xv; antipyrin, gr. lxxv; boric acid, gr. lxxv; vaselin, 3 iss.

Carron oil consists of equal parts of linseed oil and lime-water. It allays the pain of a burn, but it is a filthy preparation, and its use is followed by much pus-formation. Cosmolin gives comfort as a dressing, but should not be used on the face, lest it cause pigmentation. The elder Gross used lead paint. A solution of nitrate of potassium allays the pain. In every burn of the fingers and toes keep the burnt digits separated by gauze, lint, or rubber tissue during healing, otherwise adjacent fingers will adhere and "webbing" will result. Where extensive destruction of tissue has taken place and

sudden and overwhelming cold is caused by anemia of the brain from weak circulation and capillary embolism. To bring a partly frozen person into a warm room may cause death by embolism.

Treatment.—Frost-bite is treated as outlined on page 192. When a person is nearly frozen to death place him in a cool room, but under no circumstance, in a cold bath; make artificial respiration, rub him briskly with flannel soaked in alcohol or in whisky, and follow this by rubbing with dry hands. After a time wrap the patient in warm blankets and give an enema of brandy. Mustard plasters are to be applied over the heart and spine. As soon as swallowing is possible brandy, is administered by the mouth. As the condition improves gradually raise the temperature of the room and give hot drinks.

Chilblain or pernio is a secondary effect of cold. It is really an area of local asphyxia (page 188). It usually appears as a local congestion upon the toes, the ears, the fingers, or the nose, and now and then inflames and ulcerates. A chilblain is apt to become congested on approaching a fire or on taking exercise, and when congested, it itches, tingles, and stings. Frequent attacks of congestion produce crops of vesicles; these vesicles rupture and expose an

ulcer, which in rare instances sloughs.

Treatment.—If chilblain affects the toes, prevent congestion of the legs and feet. Order large shoes and woollen stockings, and forbid tight garters. The patient with pernio must take regular outdoor exercise and must not loiter around a hot fire. Every morning and evening he should take a general cold sponge-bath, following by rubbing with alcohol and frictions with a coarse towel, and in winter he should sleep with warm stockings on or with his feet upon a warm-water bag. When a chilblain is only a congested spot, it should be washed twice a day in cold salt water, rubbed dry with flannel, and subjected to applications of tincture of iodin and soap liniment (1:2), tincture of cantharides and soap liniment (1:6), or equal parts of turpentine and olive oil (W. H. A. Jacobson). Jacobson says itching is relieved by painting belladonna liniment upon the part and allowing it to dry. Tincture of iodin may relieve it, and so may a mustard foot-bath. A valuable preparation for itching is composed of 3j of powdered camphor and 3iv of cosmolin. A little of this ointment is rubbed in twice a day. The following prescription, the source of which I do not remember, is very valuable for itching: 3j of powdered camphor; 3iss of ichthyol; 3ss of lanolin, and 3iv of cosmolin, rubbed into the part and covered with cotton-wool. If vesicles form, paint with contractile collodion; if ulcers form, dress antiseptically. If ulcers are sluggish, use equal parts of resin cerate and spirits of turpentine. A good antiseptic and protective is the following: oxid of zinc, gr. vj; chlorid of zinc, gr. xx; gelatin, 3ij; distilled water, 3j.

#### XXXI. DISEASES OF THE SKIN AND NAILS.

Dermatitis venenata is a dermatitis resulting from irritants. It is be caused by wearing garments containing arsenic, but is generally derhus-poisoning. Rhus-poisoning arises from the poison-oak, the poison the poison-ivy, and some species of sumach. Actual touching of the poison is usually, but not always, necessary. Some suffer if they simply come them. Some people are immune to rhus-poisoning, some are slightly sustible, some are strongly predisposed. It is believed that toxicodendric is the irritant agent. The condition is most apt to arise when the skill kin is moist from perspiration.

The symptoms are burning and itching, redness and edema of the affer a jected parts. The hands and forearms are most apt to suffer, but any part may as he attacked. If the penis and scrotum suffer from rhus-poisoning there is great swelling from edema. An eruption on the hands may inoculate the popenis when that organ is handled. A vesicular eruption begins between the fing and the eruption and the fierce red edematous inflammation spread with idely over the body. There may be slight fever. The condition begins to ab

in two or three days, as a rule, and desquamation follows.

When one, knowing from experience that he is predisposed, feels t inaugural itching, he should at once apply to the parts a 1 per cent. solution of lactic acid in 95 per cent. alcohol (R. F. Ward, in "N. Y. Med. Jour.," Dec.

26, 1008).

The treatment, when a moderate area is involved, comprises the application of cloths wet with black wash or lead-water and laudanum, or a saturate solution of acetate of aluminium (R. F. Ward, Ibid.). If an extensive area is involved, apply grindelia robusta (3iv to Oj of water) or moisten the surface frequently with sweet spirits of niter. Oxid of zinc ointment, containing to gr. of carbolic acid to 3j, gives great relief. A 1:8 solution of phenomal

sodique allays pain and itching.

Furuncle, or boil, is an acute and circumscribed inflammation of the deep layer of the true skin and the subcutaneous cellular tissue following or bacterial infection of a hair-follicle or a sebaceous gland. A boil is caused by infection of a hair-follicle through a slight wound (by scratching, shaving, etc.) with the staphylococcus pyogenes aureus. Boils are very common in individuals with Bright's disease, diabetes, gout, lithemia, tuberculosis, and disorders of menstruation and digestion; and crops of boils are apt to appear during convalescence from typhoid fever. Boils are commonest in the spring, and sometimes an epidemic of furunculosis appears in a hospital, a jail, or an asylum.

The symptoms of a boil are as follows: a red elevation appears, which stings and itches; this elevation enlarges and becomes dusky in color; a pustule forms, that ruptures and gives exit to a very little discharge which forms a crust. Inflammatory infiltration of adjacent connective tissue advances rapidly, and the boil in about three days consists of a large, red, tender, and painful base capped by a pustule and a little crusted discharge.

in rare instances, at this stage, absorption occurs, but in most cases the swelling increases, the discoloration becomes darker, the skin becomes edemitous, the pain becomes severe and pulsatile, and the center of the boil becomes aised. About the seventh day rupture occurs, pus flows out, and a "core" of necrosed tissue is found in the center of a ragged opening. This core consists of the sebaceous gland and hair-follicle, which have undergone coagulation necrosis (Warren). In a day or two more the core will be discharged, and healing by granulation will begin. A blind boil lasts only three or four days and has no core. The constitution often shows reaction during the progress of a boil. Boils may be either single or multiple. The development of one boil after another, or the formation of several boils at once, is known as "jurunculosis." Boils are commonest upon the neck and the back.

The treatment consists of crucial incision, removal of necrotic tissue, irrigation with peroxid of hydrogen, touching with pure carbolic acid, and

the application of hot antiseptic fomentations.

Aleppo boils (endemic boils of the tropics) are papules appearing upon the exposed parts of the body. These papules, which ulcerate and do not cicatrize for at least a year, are due to a pathogenic bacterium and leave ineradicable scars.

Carbuncle (benign anthrax) is a circumscribed infectious inflammation of the deeper layer of the true skin and of the subcutaneous tissue, with fibrinous exudation, multiple foci of necrosis arising, and the tissue adjacent to each necrotic plug becoming gangrenous. The infection takes place through a hair-follicle. It is really a boil with extensive infiltration of adjacent issues. A boil may become a carbuncle, and pus from a carbuncle inoculated into a healthy person may cause either a boil or a carbuncle. The causative organism seems to be the staphylococcus pyogenes aureus. Carbuncle is most common in the upper part of the back and on the back of the neck. In this region the skin is very thick; each hair-follicle holds only a downy hair, is shallow, and projects but a short distance into the cutis vera. Columns of fatty tissue run from the subcutaneous tissue in an oblique direction to join the point and sides of the hair-follicle. These columns are known as columnæ adiposæ, and each one contains a sweat-gland (Fig. 710). When pus runs down one of these columns, it seeks an outlet; it cannot spread easily to the sides, so it slowly works its way to deeper tissue and from one to another interspace and finds its way to the surface through other fatty columns (Warren's "Surgical Pathology") (Fig. 711). When pus finds its way to the surface, an opening forms, hence the numerous foci of pointing; finally a large opening forms (Fig. 712). Carbuncles are most common in the spring of the year. In persons with diabetes and Bright's disease carbuncles not unusually occur.

The local symptoms in the beginning resemble those of a boil, but the constitution sympathizes from the very start (perhaps a chill and always a septic fever) and the pain is usually severe. The inflammatory area begins as a papule with an indurated base, it enlarges enormously, is boggy to the touch, is dusky in color, is edematous, and the skin is not freely movable over the deeper parts. In a few days many pustules appear, each pustule marking the site of a focus of necrosis. Large vesicles filled with bloody serum very frequently form. In some cases, about the tenth day, the pustules

rupture, the narcotic plugs are discharged, and



Fig. 710.-Columna adiposa (Warren).

toward cu carbuncle while pus center of in in the de surface th ings, each by a plug buncle in honeycom bloody pu andsubcu The entir become g and almo pain poin ordinary c about thr quires a n dangerous a carbune

(tends to produce septic phlebitis; septic clots ophthalmic veins, or in the cerebral sinuses, or in



Fig. 711,-Infiltration of columna adiposa and subcutaneous tiss

tality of facial carbuncle is at least 50 per cent. for carbuncle are the neck, the back, and the back

carbuncle is made by noting the multiple foci of necrosis and the profound constitutional involvement. A carbuncle may produce death by causing septicemia, pyemia, or profuse hemorrhage.

Treatment.—Some have suggested the treatment of a carbuncle in an early stage by injecting from five to thirty drops of carbolic acid (80 per cent.) into and around the inflammatory mass. Such a method does not promise success and necessitates dangerous delay. The best treatment if the case is seen sufficiently early is thorough extirpation while the patient is anesthetized. The entire area of the infection is thus removed, and the large wound heals by granulation and is subsequently skin-grafted. When the condition is too far advanced to admit of complete extirpation, the following useful plan should be employed:

Give ether, make free crucial incisions, remove dead and necrosing tissue and also the points of the skin-flaps with the scissors and forceps, curet pockets, arrest hemorrhage by pressure and hot water, cauterize with *pure* carbolic acid, dust with iodoform, pack with iodoform gauze, and dress with hot antiseptic fomentations. Cover the gauze with a piece of some impermeable material and lay a hot-water bag upon the dressing. Every day, or several times a day, remove the dressings, wash with peroxid of hydrogen, irrigate with corrosive



Fig. 712.—Diagram of a carbuncle (Warren).

sublimate solution, dust with iodoform, and reapply the iodoform gauze and antiseptic fomentation. Keep up this treatment until sloughs are separated, then dress with dry antiseptic gauze. Secure sleep by morphin, give quinin, milk-punch, and nourishing diet, and maintain the action of the bowels and kidneys.

Erysipelas.—(See page 215.)

Clavus or Corn.—A corn is a tender, painful, and circumscribed thickening of the epidermis, and is commonest over one of the joints of the toes. Hard corns are situated on exposed parts of the digits; soft corns appear between the digits, where the parts are kept constantly moist. Corns

are caused by pressure.

Treatment.—The wearing of well-fitting boots will usually cause a corn upon the toe to disappear. Soak the feet often in water containing bicarbonate of sodium, dry them, and apply a circular corn-plaster to the corn to take off the pressure of the boot. Another method is to touch the corn with iodin every night and pare away the hard tissue every morning. An old and valuable plan is to paint the corn every night and morning for several days with a mixture composed of salicylic acid, gr. xl; extract of cannabis indica, gr. x; and collodion and flexible collodion, of each, 3ij; then soak the parts in hot water and scrape away the mass. Soft corns are treated by washing the feet often with ethereal soap, drying, gently removing the sodden

epithelium, dusting the toes and between them ing absorbent cotton between the digits. Incuremoval of the skin from the adjacent sides of them together (thus converting two toes into oploy rest and lead-water and laudanum, and Remember that in old persons the cutting of a continuous laudanum, and painful feet of a person when the inflamed and painful feet of a person when the inflamed and painful feet with ethereal and wrapping the feet for half an hour in clot posed of linseed oil and lime-water, each, 5 ij.

Warts .- (See page 375.)

Onychia is inflammation of the matrix of the severe onychia which requires specific treatment or paronychia is suppuration of the matrix at the skin about it, of traumatic origin. It requires is buried edge of the nail, and packing with iodofor chia is referred to in page 322.

Malignant onychia, which is inflammation matrix, occurs only in a person of dilapidated requires removal of the entire nail, cauterization iodoform gauze, and the internal use of stimulan

Ingrowing toe-nail (page 173) is sometimes duedge of the nail, but usually to forcing of the sof nail. An irritable ulcer arises. The condition is removing the ingrown piece, the soft tissue at matrix, and dressing antiseptically.

### XXXII. DISEASES AND INJURIES OF

THE thyroid gland possesses important pointed out that its complete removal in a young causes operative myxedema (cachexia strumipri: moval of the gland in an elderly person does not Later knowledge indicates that removal of the certainly produces myxedema or tetany, unless at pensate. Removal of the thyroid without the permanent grave consequence, even when there a thyroid furnishes an internal secretion which dof metabolism. It is thought that the parathy poisons formed during digestion.

Wounds cause violent hemorrhage which is may cut out and forceps will not hold. The suture ligatures, purse-string sutures, the actual

bulk of the gland.

The thyroid gland may be absent at birth

congenital hypertrophy may exist.

Acquired atrophy leads to myxedema, a o presence of a firm subcutaneous swelling in the Tumors 1227

speech; mental dulness; and subnormal temperature. The condition is identical with that produced by removal of the entire gland.

Cretinism is a form of infantilism and idiocy due to atrophy of glandular elements in the thyroid, although the size of the gland is often increased. The body is dwarfed; bone development is very defective, the face, neck, and extremities resemble those parts in myxedema, and a low grade of idiocy exists. Myxedema and cretinism are treated by the internal administration of thyroid extract.

Thyroid Grafting.—Many experiments have been made and are being made on thyroid grafting in the treatment of cretinism and myxedema. Grafts have been placed under the skin, in bone at the junction of the epiphysis with the diaphysis, in the spleen, and in other regions. Very encouraging cases have been reported.

Congestion of the thyroid may be caused by violent exertion, prolonged effort, febrile maladies, and venous obstruction. It is treated by removing the cause and applying heat locally. Tracheotomy may be required.

Inflammation of the thyroid (acute or inflammatory goiter) may be nduced by a septic or febrile malady, rheumatism, muscular strain causing rascular rupture, a wound or contusion of the thyroid. But one lobe is affected. The ordinary symptoms of inflammation are present. In addition here are dysphagia, dyspnea, venous congestion of the face, epistaxis, nausea and vomiting, and possibly delirium. It may terminate in resolution, suppuration, or fibrous induration.

Tuberculosis of the Thyroid.—Is usually a part of general miliary uberculosis. It is very seldom that a local caseating focus occurs, but such

ases have been reported.

Syphilis of the Thyroid.—Early in the secondary stage there is apt to be slight and painless thyroid enlargement. In the tertiary stage gummata

may form.

Tumors of the thyroid are of various sorts. Among them are adenomata, cystic adenomata, sarcomata, and carcinomata. Eight cases of teratoma are on record (Isabella C. Herb, "Am. Jour. Med. Sciences," June, 1906). Malignant disease is unusual. I have operated on but two cases: one of cystic carcinoma in which operation was rapidly fatal, and one of round-celled sarcoma, which is living and apparently well four years after partial thyroidectomy. Malignant disease may arise in the normal, but is more apt to arise in a goitrous thyroid. In over 50 per cent, of the reported cases there is a history of antece-Malignant disease is more common in women than in men and dent goiter. is very seldom met with before the age of thirty. It is most common between forty and sixty. One should always suspect malignant disease of the thyroid gland when the growth appears rather suddenly in a patient over forty years of age. If the growth is irregular in outline and is accompanied with pain and difficulty in swallowing, the diagnosis becomes reasonably certain. Later in the case there are symptoms due to pressure upon and infiltration of the nerves; the growth becomes firmly anchored and the lymph-glands adjacent to the thyroid become involved; there may be tracheal bleeding, and perhaps fever, and eventually cachexia develops. Sarcoma or carcinoma may occur and it is seldom possible to determine clinically with which we are dealing. The cancer may be a scirrhus or an epithelioma, but is usually an adenocarcinoma.

A sarcoma may be either round cell or spindle cell in type. In malignant



Fig. 713.-Sarcoma of thyroid gland.

are hard and nodular and grow rapidly. At first the gland moves with degition, but later becomes anchored to surrounding parts. In malignant disea

the thyroid it is usual to find difficulty of swallowing and paralysis of the vocal cord on the side of the growth. Malignant disease is rapidly fatal. Many die within six months and few survive over eighteen months. Radical operation is proper only before the growth breaks through the capsule, although at any stage it may be necessary to operate in order to prevent suffocation.

Goiter. — A goiter is an enlargement of the thyroid gland not due to a malignant tumor or to inflammation. The enlargement may affect a small portion of the gland, disease of the thyroid, me tastasis occurs early in a great majority of cases, the lumgs being first involved, and then the bones and other structus wes; though it has been stated that in adenocarcinoma the lumgs are likely to escape and That solitary bone-metastasis is not infrequently noted. Sarcoma (Fig. 713) may involve one lobe, but carcinoma (Fig. 714), even at an early stage, is apt to involve both lobes (Berry, " Diseases of the Thyroid Gla and")-These growths soon pene trate the gland capsule, become anchored to surrounding parts, and involve the vocal conditrachea, and even the grea wes sels of the neck. It is after the fortieth year that malignant growths may be met with: -luti-



Fig. 714 -- Cystic carcinoma of thyroid gland.

one lobe, both lobes, or both lobes and the isthmus, and it may occur either sporadically or endemically.

Goiter 1229

here are a number of forms of ordinary goiter. The most common is is called *parenchymatous goiter* (Fig. 716). In this condition all porof the gland enlarge, and the goiter is consequently bilateral. It does

ppear first in one lobe and at a derably later period in the other, ach lobe is enlarged equally or equally. Parenchymatous is often spoken of as simple, and is sometimes, though not entire accuracy, designated hypphy of the thyroid gland.

denomatous goiter (Fig. 715) is a tion due to the growth of encapadenomata in the thyroid gland. ay be a single adenoma, but ently there are multiple growths. In both lobes may be involved, goiter, however, seems to begin a lobe; and if both lobes enone does so at a period dissubsequent to the enlarging other. Adenoma may develop



Fig. 715 .- Adenomatous goiter.

nealthy thyroid gland, but adenomatous growth is usually associated some parenchymatous growth.

estic goiter, or bronchocele, is a condition in which the chief mass of the ement is composed of a cyst or of multiple cysts. When cysts form,



Fig. 716.—Parenchymatous goiter.

the thyroid gland is usually hypertrophied or adenomatous; occasionally, however, cysts form in a non-hypertrophied thyroid. The great majority of cysts are due to cystic degeneration of adenomata; some are formed by the running together of overdistended thyroid vesicles, and some few follow blood-extravasation into the thyroid tissue. The liquefaction is due to mucoid or colloid degeneration, and the fluid of the cyst is sometimes clear and thin, sometimes viscid, and often coffee-ground in appear-

A fibrous goiter is a fibrous induration. It is likely to arise in

onchoceles, which may actually pass into a calcareous condition. By m malignant goiter is meant malignant disease of the thyroid gland, either oma or sarcoma. As stated above, such cases are not really goiters.

When hemorrhage takes place into a goiter, the condition is often spoken of as: hemorrhagic goiter. A colloid goiter is a form of parenchymatous goiter in whichthere is an extremely large amount of colloid material. Exophthalmic goiler in discussed on page 1234. Occasionally an ordinary goiter becomes exophthalmic This evolution gives rise to what the French call a Basedowified goiter (see Mores tin, in "Rev. de Chir.," Nov. 10, 1899). A goiter that develops with great rapid ity is sometimes called an acute goiter, and one that induces marked dyspneis designated a suffocating goiter. Syphilitic, tuberculous, and amyloid enlarge ments are extremely rare, but occasionally occur. Further, a goiter may be back of the sternum, that is substernal or retrosternal. A very movable goite which is now above and now below the sternal notch, is called a wandering diver goiter. A goiter within the thorax is called intrathoracic; and such goiter may be retrosternal, retrotracheal, or retro-esophageal. When a numbof persons in the same region are attacked with goiter, the condition is frequent to he referred to as epidemic goiter. When the condition is common in a certain as trict, it is called endemic goiter. When a person living in a district in which the disease is rare develops goiter, we speak of the condition as sporadic goiler. It has long been known that accessory or aberrant thyroids exist. The term aberrant is better than accessory because in some reported cases the thyroid proper was absent (V. L. Schrager, in "Surgery, Gynecology, and Obstetrics," Oct., 1906). Aberrant thyroids are masses of tissue composed of structure identical with the thyroid gland, and distinct and separate from the thyroid gland proper. Median accessory thyroids are found about the hyoid bone and are formed from remnants of the thyroglossal duct. Lateral accessory thyroids are found and develop from the remains of the lateral anlages of the thyroid (Schrager). Aberrant thyroids vary in number: there may be none, one, several, or chains of them. An aberrant thyroid may enlarge with the thyroid, may not enlarge even though the thyroid does, or may enlarge when the thyroid proper remains normal. When cachexia strumipriva does not develop after complete thyroidectomy, including the parathyroids, the patient has been saved by enlargement and functionation of accessory thyroids.

Causes of Goiter.—It is known that goiter is extremely common in the valleys at the foot of certain mountain ranges in Switzerland, southeastern France, northern Italy, the Austrian Tyrol, and in the Himalayas and the Andes. In a portion of England it is so common that it is referred to as the Derbyshire neck. It seems evident that the disease is due to the introduction of some poisonous element into the system; but what this element is, is not positively known. Some writers maintain that individual liability is developed by habits of life; others think that susceptibility depends upon hygienic surroundings; and some attach great importance to hereditary influence. The probability is, however, that the disease is due to the existence of some poisonous substance in the drinking-water. Some observers have blamed snow-water; many have laid the cause of the trouble at the door of water impregnated with salts of lime; but the real cause has not been positively demonstrated.

An ordinary parenchymatous goiter seems to be a species of hypertrophy. A number of years ago I suggested the view that the gland has undergone such an enlargement and has become distended with colloid material because the human body has demanded more of the secretion of the gland than the

normal gland has been able to supply; as a consequence, the normal gland has enlarged its capacity and increased its output.

Symptoms of Goiter.—One may determine that a growth is in the thyroid gland or is connected with it by studying a number of facts. A goiter, as a rule, follows the movements of the larynx and the trachea during deglutition, and this sign may be obtained in the great majority of instances. There are, however, rare conditions, such as hyoid cyst, in which a movement of the mass takes place during the act of swallowing, although the thyroid gland is not involved. Then, again, a malignant or an inflammatory growth of the thyroid usually becomes anchored to the surrounding tissues and does not show this mobility. Certainly, however, in the greater number of the cases the goiter moves with the larynx and the trachea during swallowing.

Goiters vary greatly in size. Cases in which the goiter was as large as an adult's head, and some cases in which the goiter hung in front of the breast-bone and reached to below the level of the ensiform cartilage, have been described. A very large goiter may have a stalk.

When the entire gland, as well as the isthmus, is enlarged, or when the isthmus alone is involved, the swelling may appear to be in the median line of the neck. If the condition begins in one lobe, the growth will, for a time at least, be distinctly one-sided; though when such a growth has attained a large size, it may displace the windpipe and come itself to the middle line of the neck.

A goiter of any considerable size pushes the sternocleidomastoid muscle externally and anteriorly, and the muscles that run from the sternum to the hyoid bone and to the thyroid cartilage overlie the front of the growth. The carotid artery is displaced externally and posteriorly. The relation of the jugular vein to the carotid artery is usually profoundly altered. The artery, as already stated, goes externally and posteriorly, while the vein is actually pulled anteriorly and is flattened out upon the side or the anterior surface of the goiter; hence the vein comes to lie to the inner side of the artery. This curious alteration in relationship is due to the fact that the common carotid artery has no branches, and therefore is pushed externally with ease; but the internal jugular vein receives branches that lie in the tumor, pull upon the vein, and prevent its displacement with the artery (Lücke).

Berry alludes to the fact that the tumor, unless it is very small, usually reaches the upper level of the sternum, and frequently passes below this level; and that only extremely large goiters hang in front of the sternum, but that it is not at all unusual for prolongations from a goiter to extend for quite a distance into the mediastinum. A substernal goiter is productive of very dangerous symptoms and offers many difficulties in diagnosis. A goiter will occasionally wander, now appearing in the neck and again disappearing behind the sternum.

Some goiters are said to pulsate. This takes place in exophthalmic goiter, the vessels of the goiter pulsating as do the other vessels of the body; but in the ordinary simple goiter, what is called pulsation of the goiter is usually the transmitted pulsation from the carotid artery.

Some of the most important symptoms of goiter are due to pressure and to the displacing of anatomical structures. Pressure upon the veins at the root of the neck causes great enlargement of the veins above the goiter and in it. Pressure upon the recurrent laryngeal nerve may induce characteristic symptoms (spasm of the glottis or paralysis of a vocal cord), but the dyspnea of goiter is due to pressure upon the trachea and not to interference with the recurrent laryngeal. Paralysis of a vocal cord is rare in non-malignant, common in malignant, goiter. Pressure upon the cervical sympathetic may cause contraction of the pupil and narrowing of the palpebral fissure (Berry). Pressure upon the cervical plexus or the brachial plexus causes paresthesia, anesthesia, or paralysis in the parts supplied by nerves from the compressed plexus. Pressure upon the larynx and the trachea may cause very great displacement, and any such displacement is productive of marked dyspnea. This displacement is usually to the side; and it may cause such a flattening out of the tracheal rings that when the tumor is removed, the trachea collapses and the patient perishes of suffocation.

A parenchymatous goiter usually begins insidiously and grows slowly. It occasionally ceases to grow for a considerable period of time, and may even shrink. It frequently enlarges temporarily during menstruation or pregnancy, and occasionally attains an enormous size by changing into the cystic form. Alterations in its consistency and outline may be due to the

developing of adenomatous masses.

In making a diagnosis between the different forms of goiter, one should remember that a fairly symmetrical, bilateral growth is probably parenchymatous; that sudden enlargements are produced by hemorrhage; that cystformation may lead to very great enlargement, and possibly to fluctuation; that if a non-malignant goiter induces dyspnea, it almost invariably does by pressing upon the larynx and the trachea, whereas a malignant goiter may do so by interfering with the nerves of the part; that a non-malignant goiter very rarely produces difficulty in swallowing, but that a malignant goiter frequently does so; and that cough often exists if there is pressure upon the larynx or the trachea, such a cough being metallic in nature and unassociated with impairment of the voice.

In any goiter there may be cerebral symptoms, such as anemia, syncope, or even convulsions. Rapidly growing goiters are often fatal, and slowly growing goiters are very rarely so. A malignant goiter grows with great rapidity, becomes adherent, infiltrates, and quickly produces metastases, and both sarcoma and carcinoma produce metastases by way of the venous system.

Metastasis of Non-malignant Goiter.—An ordinary goiter which presents no sign of being malignant may suddenly be disseminated. The deposits are apt to take place in the bones and in the lungs. Tumors have been removed without any thought of thyroid trouble being responsible, and examination has shown thyroid structure. Patel collected 18 cases of thyroid metastasis ("Tumeurs benignes du corps thyroide donnant des métastase," "Revue de Chirurgie," 29, 1904). The bones most apt to receive metastases are the bones of the cranium, the lower jaw, the vertebræ, the pelvis, and the long bones. In 4 of these 18 cases the spine was affected. Dercum has reported a case of thyroid metastasis to the spine ("Journal of Nervous and Mental Diseases," March, 1906). Colloid goiters are particularly proce to metastasis. Some surgeons maintain that if a metastatic deposit grows and destroys bone, the primary tumor should be regarded as malignant no matter what histological studies indicate.

Treatment of Goiter.—Iodid of potassium and arsenic internally have been advised; ointment of red oxid of mercury locally is advocated by some writers. The administration of thyroid extract may do much good in a case of parenchymatous goiter, but it is useless in other forms of the disease. It should be associated with the local use of tincture of iodin or ointment of red iodid of mercury. In times past it was customary to treat cystic goiters by aspiration and injection with a solution of iodin. Electrolysis may benefit a soft goiter, the negative pole being pushed into the growth, the positive pole being applied to its surface. In some cases the x-rays may prove of benefit. In considering the propriety of operation remember that a goiter which begins at puberty may pass away. We should operate on every non-malignant goiter which is increasing in size steadily or rapidly. Operation is justifiable even if there is not pressure because the mortality is very small, and it saves the patient from the possibility of malignant change, of hemorrhage, and of inflammation. If enucleation or extraglandular extirpation is performed, ether is eldom given. General anesthetics increase bleeding and are to that extent langerous. Do the operation with the aid of local anesthesia (cocain, eucain, or Schleich's fluid). It is a great advantage to have the patient conscious, because by asking him to speak during the operation the surgeon can tell if the recurrent laryngeal nerve is being approached or touched. In many cases ntraglandular enucleation is performed, in other cases extirpation. Occaionally these two methods are combined (Bergeat). Some surgeons advise imple division of the isthmus. Ligation of the thyroid arteries bas been recommended. Exothyropexy is the operation of exposing the thyroid gland,

dislocating it through the wound, and leaving it in this situation. Exothyropexy is now almost never performed, on account of the safety of the operation of thyroidectomy. Atrophy of the gland follows



Fig. 717.—Koenig's tracheotomy tube.

the operation. Enucleation, if possible, is the desirable operation. It may easily be employed for the removal of a single adenomatous, coloidal, or cystic area. Thyroidectomy or extirpation is employed when enucleation is impossible. The entire thyroid is not removed for an innocent growth: a portion of the gland is left behind, otherwise operative myxedema will probably arise. Unilateral extirpation is the method usually chosen. In sarcoma or cancer of the thyroid complete extirpation may be attempted. The operation in malignant disease will occasionally prolong life, but it will rarely effect a cure. In malignant disease tracheotomy may be rendered necessary by urgent dyspnea. The operation is often very difficult because the growth may cover the trachea, the trachea may be deviated a considerable distance from its proper position, and the veins are very large. After he performance of the operation it is usually impossible to use an ordinary racheotomy tube, and in such a case Koenig's long, flexible tube is employed (Fig. 717).

Endotracheal Goiter.—Such a goiter may be due to misplaced thyroid tissue, or may be a prolongation from the thyroid gland. Occasionally the

growth is situated in front; but, as a rule, it face of the larynx or trachea. The first symp and becomes very severe. An examination condition evident. Endotracheal goiter is muthan in the male. It is believed to begin usu though it may exist for a long time unnotice patients were forty years of age before being an endotracheal goiter is the performance of then extirpation.

Exophthalmic Goiter (Graves' Disease Goiter).—This condition was first described It is vastly more common in women than in



Fig. 718.—Exophthalmic goiter and total blindness fro protrusion of eyes (Hansell),

troubles, and abdominal and pelvic diseases. sponsible in some cases. It is frequently asso result of excessive vomiting. Many believe that the real cause is hypertrophy of the thy the gland (hyperthyroidism). This view is recall that a condition known as myxedema per opposite to those of Graves' disease and that tion, great diminution or absence of thyroid action of adrenal secretion. The administrindividual may produce some symptoms obserpartial thyroidectomy may improve or cure the probably the poisonous element.

An apparent objection to this view is that Graves' disease may exist without detectable thyroid enlargement, but this objection loses force when we recall that the thyroid may be somewhat enlarged, though we cannot detect the increase. It is probable in exophthalmic goiter that whether or not there is an excess of thyroid products passing into the circulation, toxic materials of some sort are formed in the gland and are taken into the lymph and blood. The real cause of exophthalmic goiter is not positively proved, but it seems probable that the disease is due to the action on the sympathetic system of large amount of thyroid material or of some poisonous product of thyroid activity.

In exophthalmic goiter the vessels of the gland are not dilated—in fact, they are "usually smaller and less numerous than in a parenchymatous goiter of the corresponding size" (Berry on "Diseases of the Thyroid Gland"). The surface of the gland is smooth. On section, the cut surfaces seem solid and very little colloid is visible. The enlargement is due to growth of the glandular epithelium, and this epithelial proliferation may be induced by the different

exciting causes previously mentioned.

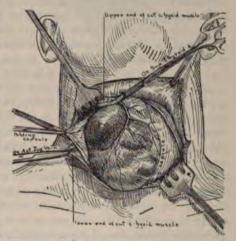
In exophthalmic goiter the lymphatics within the lobules are usually obliterated, and the lymphatics around the lobules are present in increased number and are of exaggerated size. Sometimes the thyroid becomes fibrous, and in such cases myxedema is apt to arise. In a typical case there are rapid pulse or tachycardia, protrusion of the eyeballs or exophthalmus (due to a collection of fat back of each eye), and enlargement of the thyroid gland or goiter. Either thyroid enlargement or exophthalmus may be absent—in fact, in some rare cases both are absent. The pulse-rate in most cases is from 90 to 140. Exophthalmus is present in at least 80 per cent, of cases. The enlargement of the thyroid is bilateral. Supposed unilateral enlargements are instances of Basedowified goiter-that is, are cases in which hyperthyroidism arises in the course of an ordinary goiter. A systolic bruit is usually audible over the thyroid region, and the large vessels at the root of the neck pulsate strongly because of arterial dilatation. The cardiac symptoms are of great importance. Cardiac dilatation occurs during tachycardia, and for a time, at least, disappears as tachycardia abates. Even trivial fatigue brings on temporary dilatation. Dilatation may become permanent, valvular insufficiency may arise, or cardiac hypertrophy may occur (see Grocco, in "Riv. Crit. di Clin. Med.," Jan. 2, 1904). Von Graefe's sign may be present; this is inability of the lids to follow the eyes in looking down. Stellwag's sign is retraction of the upper lids. The lids in some cases cannot be completely closed, and when the eyeball is suddenly turned up, the lid and brow may fail to act together. Moebius's sign is inability to maintain the eyes in convergence. In some cases ocular palsies exist, in others there is photophobia or nystagmus. Patients may suffer from neuralgia, colic, choreic movements, tremor, flushes of heat, and gastric crises. Tremor is practically always present when the arms and forearms are extended, the palms of the hand are turned down, and the fingers are spread apart. Widespread tremor is apt to arise from any excitement, shock, or surprise. Dyspnea often exists and albuminuria and polyuria are not uncommon. Hemoptysis, hematemesis, or mental disturbance is sometimes noted. The patient is usually greatly depressed mentally, sometimes is excited, and may have outbreaks of violent hysteric excitement or even of mania. The usual expression is one of fright. There may be insomnia, elevated tempera-

ture, excessive sweating, or sudden attacks of increased by fear or fright. Exophthalmic with osteomalacia. This fact is important in observations on the action of the parathyroid bolism. The duration of a case is entirely chronic, with remissions or actual intermission entirely well, but this result is rare. There is at any time be followed by a renewed outbre passes away rapidly, but abatement is usually gressively worse and die. Certain cases are acfatally. A man in the Jefferson Hospital die symptoms were noted. He was delirious for s

Treatment.—Thyroid extract does harm vere case should comprise rest in bed, the us and the administration of adrenalin. When he must avoid alcohol and all forms of excit sirable, but never violent exercise. Diet is to ing. Electricity is said to be of benefit. T Experiments in organotherapy are being trie Enriquez assumed that the thyroid gland fur body poisons, that an excess of thyroid secretineutralize toxin causes the condition known as symptoms of Graves's disease should disappea tered to antidote the excess of thyroid secretion Medicine," August, 1906). The two observ blood-serum from thyroidectomized dogs and ir ing from Graves's disease and claim that they of their patients, however, tetany developed. thyroidectomized goats instead of the serum of serum of thyroidectomized sheep, powder ma cretin, and the powdered flesh of thyroidect (Hubert Richardson, "Am. Med.," August thyroidectin is the dried serum of an animal fro been removed. John W. Rogers and S. P. Beinteresting studies on the production and ap makes two sera, using one or the other, acco One serum, called the normal serum, is obtain injecting them with the combined nucleoproteic thyroids; the other, called the pathological seru after injecting them with combined nucleoprote from the thyroids of Graves's disease. In on improvement and apparent cure follow the use of serum treatment is as yet undetermined. It and some deaths have followed its use. One use of goat serum may be found in the fact probably incompletely thyroidectomized. Th roids and these must be removed as well as the pation of the cervical ganglia of the sympathet low the ganglion, have been employed, and it is

have not employed the operation for this disease. Ligation of the thyroid arteries may do good. Partial thyroidectomy is the operation commonly employed in severe cases; it cures within six months 50 per cent. of the cases operated upon. Some cases do not improve; others improve slowly and relief is only partial. It is the operation which I prefer. The Mayos have obtained a splendid series of results from this operation. They have operated on 110 cases with 9 deaths, but in the last 64 cases there were but 2 deaths (C. H. Mayo, "Jour. Am. Med. Assoc.," Jan. 26, 1907); 50 per cent. of the survivors were cured; 25 per cent. showed lasting improvement in the main symptoms; 20 per cent. were greatly improved, but have temporary relapses of tachycardia and tremor. The Mayos had but one case of tetany (and that slight) in 375 operations on the thyroid gland. It is their custom to apply the x-ray daily for several weeks and then to operate. The rays produce decided

but temporary improvement. The operation is intracapsular extirpation of one lobe. Ether is given to most cases. In some cases thyroid intoxication follows operation. In other cases very rapid growth follows incomplete removal, and the operation seems actually to have done harm. Sudden death occasionally follows the operation. The removal of an exophthalmic goiter is difficult; the capsule and bloodvessels rupture from slight force. All cases should not be operated upon; in fact, only those cases should be operated upon in which medical treatment has proved toxemia or excessive dyspnea. If extraglandular extirpation is per-



Tutile, or in which there is profound Fig. 719.—Enucleation of cystic goiter; capsule toxemia or excessive dyspnea. If opened (C. H. Mayo).

formed, neither ether nor chloroform should be given. Such an operation is to be done under local anesthesia (eucain, cocain, or Schleich's fluid). The younger Kocher reports the experience of the Berne Clinic ("Mittheilungen aus den Grenzgebieten der Medicin und Chirurgie," Bd. ix). He reports 74 cases of true exophthalmic goiter, 59 of which were operated upon. Every operation was done with the aid of local anesthesia (1 per cent. cocain). In some cases partial thyroidectomy was performed; in some the thyroid arteries were ligated; in 3 cases not only were the arteries tied, but the sympathetic ganglia were resected. In these 59 cases were 4 deaths within ten days from tetany, and in 39 of the cases there were marked disturbances (tremor, irregularity and palpitation of the heart, vomiting, sweating, and elevated temperature). These abnormalities were possibly due to forcing diseased thyroid secretion into the circulation; 45 of the 59 cases were cured and 8 were greatly improved. In 3 of the fatal cases autopsy was made, but did not disclose the cause of death. Kocher believes in operation. He thinks, however, it removes but one element of the disease, and that medical treatment

may remove the others. He advises strongly a exacerbation, unless relief has been sought, but not That Kocher had 4 cases of tetany in 59 operation 110 operations seems a complete confirmation of the posterior portion of the capsule. The x-rays ficial effect upon the symptoms of exophthalmic stroy some of the secreting glandular epithelium, a of the thyroid secretion and alter its character. Of they will produce a cure. It is my custom to use the tion, in order to decrease the vascularity of the pardiminish the toxic quality of the thyroid secretion symptoms.

Operations on the Thyroid Gland.—The re operation and one beset with difficulties and dange successful operation. I have operated on 54 cases of sarcoma of the thyroid goiter without a death. I thyroid and a case of adenoma of the inferior righ these cases is considered a goiter). In 200 cases of had a mortality of 1 per cent. following extirpa .4 per cent. Certain anatomic points are to be b jugular vein is frequently found internal to the ca goiter (because the vein has branches which rur vessel against the thyroid). The recurrent laryng side of the trachea back of the gland, and is aga passes through the cricothyroid membrane. very close to the inferior thyroid artery, sometime under it. On the left side it is deeper and not so thyroids are behind the thyroid and usually behin

In view of the fact that one or both recurre paretic from pressure, all cases should be examine before the operation to determine this point, as, only, the sound vocal cord may possibly compenmidline. Otherwise in such conditions the pafollowing operation, leading the operator to thinl (C. H. Mayo, in "Surg., Gynecol., and Obstet.,"

Intraglandular Enucleation (Socin's Operation adenoma or cyst of the thyroid gland is removed, tissue being left in place. The capsule of such a The operation of enucleation is not suited to the and it cannot be performed for parenchymatous; Intraglandular enucleation is performed as follo by an oblique or by a horseshoe-shaped incision. the capsule of the thyroid gland and through the gor solid tumor is reached. As a rule, the tumor fact that its color differs from the color of the th turned out by the fingers, a special scoop, the kni In some cases a cyst can be most easily evacuate cised and emptied and its wall is then grasped we tumor should, if possible, be removed intact. T

arily with gauze, the edges of the cavity are grasped with forceps, the gauze is removed, and every bleeding point is carefully ligated. The wound is closed by three layers of sutures—"one in the gland, one in the muscles, and a third in the skin" (James Berry on "Diseases of the Thyroid Gland"). If the tumor is large, drain for twenty-four hours; otherwise, do not drain.

Enucleation is a very successful operation if performed upon properly

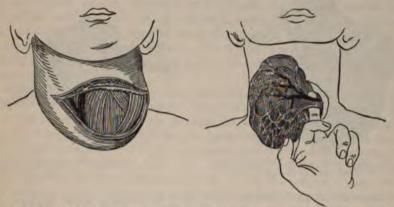


Fig. 720.-Kocher's transverse incision exposing the muscles and median veins of the neck (Kocher).

Fig. 721.-Isolating the accessory veins (Kocher).

selected cases, and can be performed rapidly, but the arrest of bleeding is often tedious and troublesome.

Extirpation.—This term means removal of the entire gland (complete thyroidectomy) or a portion of the gland (partial thyroidectomy) with the glandular capsule, the operation being an extracapsular procedure. Usually but one lobe is extirpated. This method enables the operator to tie the chief vessels before he cuts them, and as his vision is not obscured by bleeding,



before ligation (Kocher).

Fig. 722.-Exposure of veins at lower end Fig. 723.-Dislocation of the goiter toward the right (Kocher).

he can avoid cutting the glandular capsule, which would be sure to provoke copious bleeding, and he keeps a safe distance away from the recurrent laryngeal nerve.

If the patient suffers from dyspnea, a general anesthetic is contraindicated. It is best in any case not to use one. Local anesthesia is reasonably satis-

factory and is far safer. The patient is placed a little raised and the neck laid upon a sand-p back as far as is consistent with comfortable re

An oblique incision, a horseshoe-shaped ir incision (Fig. 720) may be made. I usually em

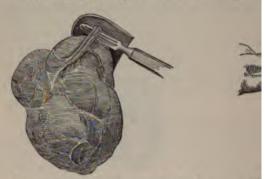


Fig. 724.—Isolation of the superior thyroid artery and vein (Kocher).

Fu

incomplete horseshoe, the convexity being do tissues are divided, each layer being infiltrabefore it is cut. Vessels are carefully tied a The muscles which run from the sternum to cases be separated, but the extirpation of a la division of the muscles high up. The capsul



Fig. 726.—Isolation of the venæ thyreoideæ imæ (Kocher).

is separated from external parts (Figs. 721, 72: tion of the gland is cleared. The superior t with two ligatures each, and divided between clearing of the gland is carried on toward the large veins are encountered and tied (Fig. 726 lobe is cleared and the inferior thyroid vessel the recurrent laryngeal nerve can be located.

with a blunt instrument, the patient's voice becomes metallic. A deliberate attempt is made to locate it and the patient is engaged in a conversation requiring answers while the surgeon is investigating. The lobe is lifted from its bed and dislocated from the wound and the inferior thyroid vessels are tied close to the border of the gland in order to avoid the recurrent laryngeal nerve (Fig. 725). The vessels are tied and cut across as were the superior thyroid vessels. The isthmus is next exposed, clamped, ligated, and cut across, every care being taken to prevent colloid from being squeezed into the wound (Fig. 727). After dividing the isthmus, any bleeding point is ligated and the stump is cauterized. The divided muscles are sutured with catgut, a drainage-tube is inserted, and the superficial wound is closed with sutures of silkworm-gut.

Intracapsular Extirpation.—This operation is warmly advocated by the Mayos. I have employed it in my last 10 cases. The preservation of the posterior portion of the capsule protects the recurrent laryngeal nerve and greatly lessens the risk of injuring the parathyroids. Ether is given unless there is grave respiratory difficulty with myocardial degeneration, and one-half an hour before administering the ether the patient is given a hypodermatic injection of gr. 4 of morphin and gr. 100 of atropin. When anesthetized, the patient is placed in the reversed Trendelenburg position and the shoulders are elevated (C. H. Mayo, in "Surg., Gynecol., and Obstet.," June, 1907). Kocher's transverse collar incision is made. Muscles are separated or divided as in ordinary extraglandular extirpation. If the ribbon muscles are divided the cut is made near their upper insertion to save their nerve supply and prevent the muscle scar from being in line with the skin scar. The gland is elevated. The vessels entering and leaving the raised lobe are double clamped and tied. The capsule is incised along the outer side of the gland, is pushed back with gauze, and the lobe is drawn toward the midline, and vessels are caught by forceps, the tissues being grasped in line with the midline of the body (C. H. Mayo, Ibid.).

Every structure bearing any resemblance to a parathyroid is allowed to remain. The isthmus is clamped, divided, and closed by suture. The rouscles and skin are sutured. Drainage is required after removal of large

growths, a separate incision being made to permit of it.

Dangers in Goiter Operations.—During any operation for goiter sudden death may occur. In some cases a general anesthetic is responsible. In others suffocation arises from pressure upon or bending of the trachea or collapse of the trachea as the goiter is lifted from its bed. In rare cases langerous dyspnea arises from irritation of the laryngeal nerves, and cardiac inhibition may be induced in the same manner. The parathyroids may be injured or removed and myxedema may result. Rough handling and flooding the wound with colloid may be followed by great and even fatal hyperthyroidism. The trachea or esophagus may be opened. The recurrent laryngeal nerve may be injured. Air embolism seldom occurs. Reactionary or secondary hemorrhage is usually due to slipping of the ligature on the superior thyroid artery "caused by including a piece of muscle" (C. H. Mayo, Ibid.).

Acute Thyroidism (Hyperthyroidism).—When colloid from the thyroid is squeezed into the wound during the operation or leaks into it later, it is absorbed and may produce serious symptoms or even death. This is most

apt to happen in exophthalmic goiter. The symptoms always apear within forty-eight hours and usually within twenty-four hours. Someone they arise quickly after operation. In some cases in which this happen the patient never reacts from the operative shock, but develops a very noil pulse and intense dyspnea, and dies in a few hours. In less severe cases there is a period of circulatory excitement, dyspnea, and elevated temperature (hydrocolloid, by cauterizing the stump, by washing the wound with adrenalin solutor, suturing the capsule over the raw stump of the gland, and inserting drainage.

The Parathyroid Glands.—These glands were discovered by Sandstrom in 1880; and their vital functions were pointed out by Gley. He

showed that removal of the parathyroids causes tetany.

The parathyroids are brownish red and are larger in adults than in infinite

They are constant in man, never being congenitally absent.

They are usually four in number and are usually placed external to the thyroid capsule. In some cases, however, one or more of them may be found embedded in the thyroid gland, but even when they appear to lie within the thyroid they are always separated from it by a capsule of connective tisse.

While there are usually four parathyroids, there may be only time, or there may be six, seven, or eight. Accessory parathyroids may be food over wide areas. One was discovered by Rogers and Ferguson in the middle of the posterior portion of the pharynx; and there was found in the thoratly

Ogle a gland that was partly parathyroid.

From their situation the parathyroids are divided into superior, or extendand inferior, or internal. Walsh describes these glands in adults as belt each from 6 to 7 mm. in length, 3 to 4 mm. in breadth, and 1½ to 1 mm. in thickness. Each of these glands is supplied by a terminal artery, and the are rial supply is very largely obtained from the inferior thyroid artery or from the branch of anastomosis between the superior and inferior thyroid vessels.

If the parathyroid glands are extirpated from an animal, tetany develops. This is positively the case in dogs. These glands certainly have most important functions in the metabolism of the body. MacCallum and Vogtin ("Johns Hosp. Bull.," March, 1908) believe that damage or removal of them

causes great changes in calcium metabolism.

Very little is known of diseases of the parathyroid glands. A few use of tumor have been reported, each being an example of work-hypertrophy or a adenoma. One of these cases was reported by the author in "Surger, Grecology, and Obstetrics," Jan., 1909. In this case the tumor was removed under the impression that it was an adenoma of the right lobe of the thyroid gland. The pathologic report, however, showed it to be a parathyroid. No mobile of any kind followed the operation; though at a later period enlargement of the opposite side of the neck occurred. This has been let alone through lest that it may be a left parathyroid.

Some persons have maintained that deficiency of parathyroid sertion is the cause of paralysis agitans, but this idea has been warmly combated as lacks evidence. Several observers believe that there is a deficiency of parafi-

roid secretion in exophthalmic goiter.

In view of the well-known fact that removal or damage of the partitives will result in tetany, provided that several of these glands or all of these

damaged or removed, it becomes the duty of the surgeon, when operating for goiter, to exercise the utmost care that he does not remove any of these bodies. The safest way to avoid them is to retain the posterior portion of the capsule of the thyroid gland. If, during an operation, any small body that resembles a parathyroid is detected, it should be let alone; or if such a body has been accidentally removed, it should immediately be implanted into the capsule of the lobe of the thyroid gland that has been left undisturbed. It is highly improbable that the removal of even both parathyroids on one side will cause tetany if there are two normal parathyroids on the opposite side.

On account of the possibility of the development of tetany, the question of the transplantation of parathyroids from animals becomes extremely important. Halsted has made some very valuable experiments upon the auto- and isotransplantation of the parathyroid glands in dogs ("Annals of Surgery," Oct., 1907; "Jour. of Experimental Med.," vol. xi, No. 1, 1909). He has shown that if the parathyroid be transplanted into an animal with normal parathyroids failure will follow, and the transplanted glandule will disappear. If, however, there is parathyroid deficiency in the animal into which the transplantation is made, the glandule will attach itself and grow. He obtained the best results by placing the parathyroid beneath the posterior sheath of the rectus muscle of the abdomen. Some observers have placed it in the spleen; others, within the peritoneum and in various other regions.

If tetany follows an operation, it may be treated by the intravenous, rectal, or stomach administration of a 5 per cent. solution of lactate of calcium (MacCallum and Voegtlin, Ibid.). Beebe and Berkeley have prepared a parathyroid serum that they claim to be efficient. Charles H. Mayo maintains that in tetany either the serum or the calcium lactate should be used, in the hope of tiding the patient over until parathyroid glands can be secured and implanted ("Annals of Surgery," July, 1909). Joseph H. Branham ("Annals of Surgery," August, 1908) has reported tetany following thyroidectomy cured by the subcutaneous injection of parathyroid emulsion. The emulsion was made by grinding up fresh glands of beeves in a mortar, and then pouring 400 cc. of sterile salt solution into the mortar. The preparation was filtered through sterile gauze and was administered beneath the patient's breast.

When tetany begins to develop in a patient there are usually headache, dizziness, and pain in the extremities. The muscles in one or both forearms and hands are liable to be affected. The hand flexes at the wrist, while the fingers are extended, and in some cases the forearm flexes at the elbow. Now and then the fingers will flex at the metacarpophalangeal joints, but the distal phalanges will remain extended. These spasms are painful. Similar spasms may occur in the feet and toes. In the most severe cases the trunk muscles and those of the chest, throat, and eye may be involved.

Trousseau, years ago, showed that a spasm may be brought on in the affected limb by pressing upon the nerve-trunks and blood-vessels; this is called the *Trousseau sign*. Pressure upon the facial nerve may induce the spasms, and it is called *Chvostek's sign*. Erb's sign is a great increase in the galvanic irritability at the motor nerves. Hoffmann's sign is excessive sensitiveness of the sensory nerves.

Tetany due to absence of the parathyroids will inevitably prove fatal without active treatment.

## XXXIII. DISEASES AND INJURIES O

Wounds, Ruptures, and Occlusions of -It was long believed that wounds of any almost certainly fatal. It is now known that root of the neck are rarely very dangerous u to the vein. A wound of the duct is rarely se because the adjacent vital structures are apt t and death rapidly ensues. Wounds of the occasionally, but very rarely, are inflicted duri tau speaks of 12 cases thus inflicted; in 8 cases culous glands, in 3 for malignant glands, and clavian artery. One alleged danger of wound into the adjacent vein. This is said to have ha the short end of the cut duct does not bleed, th orrhage. In Fullerton's case, when a groove the stump of the duct and by way of a termin appeared. In most cases the injury is not rec when white fluid escapes from the wound. or may cease spontaneously. If it continues, strength. I assisted Dr. Keen in the case in wh at the time it was inflicted. A thin fluid was from a tear in the duct. It is to be remembere part of the duct is very variable and sometime the clavicle. There was I death in 17 records C. E. Briggs, in "Amer. Med.," Sept. 21,

The discharge from a cut duct may conting more flows out during twenty-four hours. It tional effects will sooner or later become evide klin. Woch.," Nov. 28, 1901) it was not known until the stitches were removed from the wound found distended with chyle and Schoff packed it days later the patient died from chylothorax and

Rupture of the thoracic duct or of the receptraumatism or be a secondary consequence Rupture leads to death by starvation, or to fa fluid (Harvey W. Cushing, in "Annals of Surg of the main duct may be followed by ruptu Gradual occlusion by a tuberculous or inflamm any serious symptoms. Cushing assumes the current is reversed and is taken up by the rip obstruction masses of dilated lymph-vessels at the thorax and abdomen. If lymph-vessels according to the situation, there arises "chylous or chylous diarrhea" (Harvey W. Cushing, "An

Treatment of Wounds.—If the wound in divide the duct, and if the duct wound is disco

suture the duct. Allen sutured the duct and had no further leakage. Keen sutured the duct and recovery followed. If the duct is completely divided, follow Cushing's advice: "It would seem advisable to place a provisional ligature about the duct on the proximal side of the wound, and to control the leakage, if possible, by a gauze tampon. This would act as a safety-valve, and allow chyle to escape, if the pressure in the duct became too great and there was difficulty in establishing a collateral lymphatic circulation. The patient meanwhile should be given a meager diet. If the leakage should become uncontrollable and threaten starvation, the provisional ligature should be tied, with the hope of a final readjustment of collateral circulation or trusting in the presence of some anomalous anastomotic branch which might suffice to carry the lymph into the venous circulation" ("Annals of Surgery," June, 1898). Fullerton tied both ends of a divided duct and the patient recovered ("Brit. Med. Jour.," June 16, 1906). Deanesley ("Lancet," Dec. 26, 1903) inserted the divided duct into the internal jugular vein and sutured it in place. was some leakage, but recovery ensued. After ligation the duct on the proximal side of the ligature may distend greatly and may actually rupture. When a wounded duct is leaking, the patient should be fed exclusively on proteids. The diet should be scanty and the patient must be kept absolutely quiet in order to keep pressure in the duct at as low a level as possible during the establishment of a collateral lymphatic circulation (Fullerton).

Lymphangitis is inflammation of lymphatic vessels. Reticular or capillary lymphangitis, which is inflammation of lymphatic radicles, is seen in some circumscribed inflammation of the skin. It is apt to attack the hands, causing redness and swelling, fading at the point of initial trouble while it spreads at the periphery; it is caused by micro-organisms derived from decomposing animal matter (Rosenbach). Erysipelas also causes it (see Erysipelas). Tubular lymphangitis, which is due to the entry into the lymphatic ducts of virulent micro-organisms or toxic materials, is seen after the infliction of dissecting-wounds, septic wounds, snake-bites, etc. It is announced by edema and by minute, hard, red streaks running from the

wound up the extremity. Suppuration may occur.

Septic or infective lymphadenitis, or inflammation of the glands, may follow lymphangitis or may be due to the deposition of infective material, the lymph-vessels not being inflamed. In this form of lymphadenitis there are pain, tenderness, and swelling; in severe cases there are a chill and a septic fever. Suppuration way arise. The treatment is to drain and asepticize the wound, to apply iodin, blue ointment, or ichthyol over the glands and vessels, and to employ rest, heat, and compression. Internally, milk-punch, quinin, and nourishing diet are required. If the glands do not rapidly diminish in size after disinfection of a wound, and if they are in an accessible region, exirpate them. If suppuration of the glands occurs, incise and drain.

Acute lymphadenitis, or acute inflammation of the lymphatic glands, may be due to tubercle, syphilis, glanders, cold, or traumatism. Suppuration may or may not occur. In inflammatory lymphadenitis there are pain,

heat, and nodular swelling. In severe cases there is fever.

The treatment is to asepticize any area of infection, place the glands at rest, apply heat and ichthyol ointment, or inject into the gland every day 5

minims of a 3 per cent. solution of carbolic acid to prevent suppuration. the glands do not rapidly shrink, extirpate them. If pus forms, evacusit, drain, and asepticize.

Chronic lymphadenitis is almost invariably syphilitic or tuberculou. It requires constitutional treatment and the local use of ichthyol, iodin, blue ointment. If these remedies are not rapidly successful, tuberculous glands should be removed, but syphilitic glands will rarely require sucradical treatment.

Lymphangiectasis (varicose lymphatics), or dilatation of the lymphatics vessels, is due to obstruction. Many external causes may produce obstruction.



Fig. 728.—Spurious elephantiasis. No filariæ found. Born and ilved in Philadelphia.

tion; for instance, the remov= or suppurative annihilation a considerable group of lym phatics; pressure of a sca or of a new-growth up lymph-vessels; tuberculosis neoplasm of a group of glane ?-In many cases of external pressure upon lymphatics there is no lymphangiectasis because the lymph finds other channels. In fact, it has been proved that ligation of a large lymphatic trunk is not of necessity followed by lymphangiectasis. Even when the condition arises from external pressure, it is usually temporary, although, particularly if glandular tumors exist, it may be permanent.

The persistent cases are usually due to obstruction within the ducts, for instance, endothelial proliferation as a result of chronic lymphanguis,

or recurrent attacks of acute capillary lymphangitis (erysipelas) or ordinary acute lymphangitis; or tuberculosis and other chronic infections. There may be such a condition as primary intralymphatic endothelial proliferation ("Med. Record," Sept. 6, 1902). Blocking with filarial worms may occur, and if it does, the lymphangiectasis is usually situated in the pubic, the inguinal, or the scrotal region, or on the inner side of the thigh. There are two forms: the varicose, in which the vessels have a tortuous outline, like varicose veins, but are covered only with surface epithelium; and lymphatic warts (lymphangioma circumscriptum), in which wart-like masses spring up, these masses being covered with epithelium and filled with lymph. In most cases of lymphangiectasis there is considerable hard edema. Periodic attacks of pain and redness occur in the area of disease, and usually at such

times fever develops. Rupture of the dilated vessels causes a flow of lymph (lymphorrhea). Infection and erysipelas are apt to occur; it may be over and over again. It is uncertain whether these repeated attacks of erysipelas cause and maintain or are predisposed to by lymphangiectasis.

Treatment.—If the entire area can be removed, it should be extirpated. Maitland ("Brit. Med. Jour.," Jan. 25, 1902) shows that many varices are ocal and can be removed. If the varices are only partially removed, lymphor-

hea will probably develop.

Lymphangioma is an advanced stage of lymphangiectasis (page 362). The treatment in mild cases is to pierce each vesicle with the negative pole of a galvanic battery and pass a current. In severe cases destroy the mass with the Paquelin cautery or excise it with a knife or with scissors.

Elephantiasis. —
True elephantiasis (elephantiasis arabum) is chronic hypertrophy of the skin and subcutaneous tissues following upon a lymphangiectasis produced by a nematode worm (the filaria sanguinis hominis).

Spurious elephantiasis (Fig. 728) is hypertrophy of the skin and subcutaneous tissue due to chronic inflammation (for instance, in a leg which possesses an ancient ulcer, or in the scrotum of a man with urinary fistula).

The treatment is massage and bandaging, sometimes ligation of the artery of supply, extirpation, or amputation.



Fig. 729.—Hodgkin's disease (Patterson).

Tuberculous Glands.—(See page 253.)

Lymphadenoma (Malignant Lymphoma; Hodgkin's Disease; Pseudoleukemia).—The term lymphoma is used loosely to designate any persistent swelling of a lymphatic gland or glands. Lymphadenoma means a swelling of lymph-glands or lymphadenoid tissue, which swelling is progressive in character, involves group after group of glands, is associated with anemia, and often accompanied by secondary growths in the abdominal viscera. Fig. 729 exhibits a case of Hodgkin's disease.

This disease is most common in those under forty, and affects males far more frequently than females. In many cases the disease arises slowly in apparently healthy glands, and exists for some time before it takes on signs of malignancy and invades distant glands. In some cases the disease has tendency to generalization from the start; in others it appears to remain locatized for many months. A gland enlarged from irritation or from tuberculous disease may become lymphadenomatous, and tubercle bacilli can sometimes be found in lymphadenomatous glands. Lazarus asserts that the disease is lymphosarcoma and the tuberculosis accidental. Musser, Sternberg, and others believe that tuberculosis is the disease. Some few believe that lymphadenoma is really tuberculosis, but this view seems to have been definitedly disproved.

That the disease is at least similar to sarcoma seems certain. That it is a variety of sarcoma is highly probable. There is a form of tubercule sis strongly resembling Hodgkin's disease, but I do not believe that the processes are identical. The glandular and splenic enlargements are neoplated and not hyperplastic. The new tissue formed is called lymphadenoid tissue and, according to Banti, it is often atypic, tends to invade glandular trabectand and capsules, sometimes adjacent tissue, and gives origin to metastases.

Leukemia and pseudoleukemia are closely related, and both, according to Banti, are sarcoma. In leukemia the influence that stimulates proliferation falls chiefly upon the bone-marrow; in Hodgkin's disease, upon the lymnodes (Neumann, quoted by Coley, in a forceful article maintaining that Holgkin's disease is a type of sarcoma, "Transactions American Surg. Assoc.," 19—8).

Symptoms.—The glands in the neck are usually involved first, but the disease may begin in the axillary glands, the thoracic glands, or the in the abdominal glands.

Two or more regions are sometimes involved simultaneously or almost simultaneously.

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When the disease begins in the neck it affects at first one side, and after many weeks or months the other side becomes involved. The glands are at first hard, separated from each other, movable, and the skin moves freely over them. Later the large glands weld together and form great masses upon both sides of the neck and in the axillæ, which may obstruct respiration.

After a time a very large mass may break through its capsule and infiltrate adjacent structures, and in very rare cases the skin becomes adherent and finally breaks. Intrathoracic symptoms point to involvement of the thoracic glands. It may be possible to palpate enlarged abdominal glands.

The leukocytes may be increased to 20,000 or more, but in many cases the count is normal and the relative proportion of the varieties remains normal. In a certain percentage of cases, without any increase in the number of leukocytes, there is great relative lymphocytosis. Early in the case the number of red cells may be unaffected, but after a time anemia develops. A fall in hemoglobin is noted early and this fall is somewhat more rapid than the decrease of crythrocytes ("Clinical Hematology," by J. C. DaCosta, Jr.).

The spleen is enlarged; the thyroid may be enlarged. When anemia becomes marked there are the ordinary symptoms which go with it, viz, palpation, breathlessness, indigestion, vertigo, headache, pallor, and sometimes epistaxis. Occasionally, without obvious reason, the glands suddenly increase in size or rapidly undergo a notable but temporary diminution.

Slight fever exists at times in many cases, and ague-like paroxysms may occur. During the existence of fever the glands usually increase rapidly in size

Diagnosis.—In a wide-spread case the diagnosis is easy; in a localized case it is difficult. True tuberculous glands are most apt to first appear in the submaxillary triangle; lymphadenomatous glands, in the root of the neck or in the occipital triangle. Tuberculous adenitis is most common in children. As a rule, tuberculous glands caseate, but they may remain localized for years if caseation does not occur. The tuberculous glands usually soon become adherent and immovable. Lymphadenoma is most common after twenty, rarely remains localized for more than a few months, rarely softens unless very large, and the glands are separated and movable until a huge mass forms. Early softening, prolonged limitation to one region, and absence of pronounced anemia in a person under twenty point to ubercle. In doubtful cases a gland should be removed for microscopical and bacteriological study.

In widespread tuberculous lymphatic involvement, simulating Hodgkin's lisease, fever is far more likely to be present than in Hodgkin's disease. La-Roy ("Archives Internat. de Chir.," 1907, vol. iii) points out that tuberculous plands are but little improved by the x-rays, whereas, enlargements in Hodgcin's disease may be greatly benefited, and that in tuberculous conditions here is no particular tendency to hemorrhage and there often is in Hodgcin's disease. Coley shows (Ibid.) that the patients with Hodgkin's disease

eact strongly to the toxins of ervsipelas.

Prognosis.—The disease is almost always, if not invariably, fatal. Most cases die within three years, some die within six months, some few live four or five years or more.

Treatment.-If the glands are localized to one side of the neck, or even to both sides of the neck, remove them. Early removal before dissemination has occurred may possibly save the patient. If early or radical removal is not possible, do not operate, but treat the patient with nutritious food, tonics, course of arsenic, the mixed toxins of erysipelas and the bacillus prodigiosus, and applications of the x-rays. Coley treated a case with the mixed toxins and after two months the lymphatic and splenic enlargements entirely disappeared. Seven months later the patient was still well ("Transactions of Am. Surg. Assoc.," 1908). Efforts are now being made to obtain a curative serum. Beck makes nucleoproteid serum from the glands of cases of Hodgkin's disease.

### XXXIV. BANDAGES.

A BANDAGE is a fibrous material which is rolled up and is then emploted to retain dressings, applications, or appliances to a part, to make press are, or to correct deformity. It may be composed of flannel, of calico, of bleached muslin, of plain gauze, of gauze infiltrated with plaster-of-Parisoaked in silicate of sodium, or of gauze wet with corrosive sublimate so ution. Unbleached muslin, which is the best material for general use as washed to remove the sizing, is torn into strips, and the edges are strip and of selvage. One end is folded to the extent of six inches, this is folded up that itself again and again until a firm center is formed, and over this center bandage is rolled. In a well-rolled bandage the center cannot be pushed of the roll. A roller bandage is divided into the initial end, which is within the roll, the body or rolled part, and the terminal end, which is free. In applying a bandage the outer surface of the terminal end is first laid upon the part.

A cylindrical part of the body may be covered by a circular banda ge. each turn exactly covering the previous turns. A conical part may be covered by a spiral bandage, each turn ascending a little higher than the previous turn. As each turn of a spiral bandage is tight at its upper and loose its lower edge, the reverse was devised to correct this inequality; hence conical part should be covered by a spiral reversed bandage. To make a reverse, hold the roller in the right hand, start the bandage obliquely upward (do not have more than six inches of slack), place the thumb across the free-sh turn, fold the bandage down without traction, and do not make tracti-on until the turn has been carried well around the limb. A projecting point is covered with figure-of-eight turns. The groin, shoulder, breast, or axi can be covered by figure-of-eight turns, each succeeding turn ascending a small covering two-thirds of the previous turn and forming a figure like "the leavest on an ear of corn." Such a figure is called a "spica." In bandaging extremity the peripheral turns should be tighter than the turns nearer time body. Never apply a tight bandage to the leg or the arm without including the foot or the hand. In firm dressings of the forearm and arm it is well leave the ends of the fingers exposed, and use them as an index of the comdition of the circulation in the part. In firm dressings of the leg and thi leave the toes exposed.

Spiral Reversed Bandage of the Upper Extremity.—To apply this form of bandage use a roller two and a half inches wide and eight yards



Fig. 730.-Spiral reversed bandage of the upper extremity.

long. Take a circular turn about the wrist, and a second turn to hold the first; pass obliquely across the back of the hand to the extremities of the fingers; ascend the hand to the root of the thumb by several spiral turns;

cover the wrist by ascending figure-of-eight turns; ascend the forearm by spiral reversed turns; cover the elbow by a figure-of-eight, and the arm by spiral reversed turns; end the bandage by two circular turns, and pin them together (Fig. 730).

Spiral Bandage of All the Fingers (Gauntlet).—The gauntlet bandage requires a roller one inch wide and three yards long. Take two circular turns around the wrist, pass obliquely across the wrist to the root of the



Fig. 731.-Gauntlet bandage.



Fig. 732.-Demi-gauntlet bandage.

humb, and descend to its tip by spiral turns; cover in the thumb by ascending spiral turns, and return to the wrist. Cover successively each finger in the same manner, and terminate by two circular turns around the wrist (Fig. 731).

Spiral Bandage of the Palm or Dorsum of the Hand (Demi-gauntlet).—The demi-gauntlet requires a roller one inch wide and three yards long.



Fig. 733.-Spica of the thumb.

This bandage has only a limited value; it must not be applied tightly, as it makes much pressure at the finger-roots, but leaves the fingers free. If it is desired to cover the palm, supinate the hand; if to cover the dorsum, pronate the hand.

Take two circular turns around the wrist, sweep around the root of the thumb, and return to the point of origin. Treat each finger in the same way. End by circular turns around the wrist (Fig. 732).

Spica of the Thumb.—For this bandage use a roller one inch wide and three yards long. Start at the wrist, and reach the tip of the thumb as an applying a spiral bandage of a finger. Make a series of ascending figure-of-eight turns between thumb and wrist, each ascending turn overlying two-hirds of the previous turn; terminate with a circular of the wrist (Fig. 733).

Selva's Thumb Banlage (Fig. 734).—Lay the erminal end of the bandage on the outer side of the secend phalanx of the thumb, lear the base of the phaanx. Carry it over the almar side of the pulp of



Fig. 734.—Selva's thumb-bandage applied.

he last phalanx to the inner side of the second phalanx. The surgeon holds this urn in place with his left thumb and index finger. The roller is returned in a ecurrent manner to its place of origin, overlaps the preceding turn, and is placed s much as possible on the dorsum. The roller is carried over the dorsum

long. Apply as a spiral reversed bandage of the lower extremity until the metatarsus is well covered. Carry the bandage, parallel with the margin of the foot (the inner or outer margin, according as to whether it is the left foot or the right), around the posterior aspect of the heel, along the opposite margin of the foot to cross the original turn at the median line of the dorsum. Make a number of these ascending turns, each turn covering in three-fourths of the previous turn; terminate by circular turns above the ankle (Fig. 738).

Crossed Bandage of Both Eyes (Figure-of-eight of Both Eyes).— Take a roller two inches wide and six yards long. Make a circular turn around the forehead from right to left, a second turn to hold the first, a turn downward over the left eye, under the left ear, around the back of the neck, and upward under the right ear and over the right eye; repeat these turns, and terminate by a circular turn of the forehead (Fig. 739).

Barton's Bandage (Figure-of-eight of the Jaw and Occiput).— Take a roller two inches wide and five yards long. Place the initial extremity of the bandage behind the inion; pass over the right parietal bone, across the



Fig. 739.—Crossed figure-of-eight bandage of both eyes.



Fig. 740.—Barton's bandage or figure-of-eight of the jaw.

vertex, down the left side in front of the ear, under the chin, up the right side in front of the ear, across the vertex, and across the left parietal bone to the point of origin. A turn is now taken forward along the right side of the jaw to the chin, and backward along the left side of the jaw from the chin to the nape of the neck; repeat these turns, and pin the points of junction (Fig. 740). In Barton's bandage the ear lies in an uncovered triangle. The bandage may be finished by circular turns around the forehead. Barton's bandage is used for fracture of the lower jaw.

Borsch's eye-bandage is convenient and useful (Fig. 741). A narrow bandage is laid along the head and permitted to hang down the face in front of the sound eye. A circular bandage is applied around both eyes and over the narrow bandage (A). The narrow strip is lifted and pinned, and the sound eye is thus uncovered. Of course, the posterior end of A should first be pinned to the circular turn.

Gibson's Bandage.—Take a roller two inches wide and six yards long.

Make three vertical turns around the head and the jaw in front of the ear;

# Bandages

erse the bandage above the level of the ear, and carry it horizontally und the forehead and head three times; drop the bandage to the mape the neck, and take three turns around the neck and jaw; terminate by sing from the nape of the neck a half turn upward, carrying the bar dage ward to the forehead, and pinning it over the neck and over the forehead.





Fig. 741. -Borsch's eye-bandage: A, First step; R, second step.

Pin each point of junction (Fig. 742). Gibson's bandage is used for fract ure

of the lower jaw.

Crossed Bandage of the Angle of the Jaw (Oblique Bandage of Jaw).—Take a roller two inches wide and six yards long. Make a circular turn around the forehead toward the affected side, and a second turn to hold the first; take the turn to the back of the neck; carry it forward on the sound side, under the ear and chin; now make a series of turns around the head and jaw, in front of the ear on the injured side, but back of the



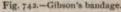




Fig. 743.—Oblique or crossed bandage of the angle of the law.

on the sound side: these turns successively advance on the injured side only terminate by going backward under the ear of the sound side to the nat of the neck, and then by taking two circular turns around the forehead (Fig. 743). This bandage is used for fractures of the ramus of the jaw and holding dressings upon the face and the cranium.

Spica of the Groin (Figure-of-eight of the Thigh and Pelvis).—For one groin the roller is three inches wide and seven yards long; for both groins, hree inches wide and ten yards long. Take two circular turns, from right o left, around the waist, then down over the front of the right groin, around he back of the thigh, up over the front of the right groin, around the waist, town over the front of the left groin, round the back of the thigh, up over he left groin, and around the waist. The map being thus laid out, the



Fig. 744.-Spica of the groin.



Fig. 745. - Spica of the shoulder.

turns are continued and ascended, each turn overlying one-third of the previous turn, and the bandage is completed by a circular turn around the waist (Fig. 744). Pin the crossed pieces.

Spica of the Shoulder.—Take a roller two and a half inches wide and seven yards long. Make a circular turn and several spiral reversed turns around the upper arm; then, coming from behind forward, carry the

bandage over the shoulder, across the front of the chest, through the opposite arm-pit, and return across the back to the shoulder. Make successive and advancing turns (Fig. 745).



Fig. 746.—Figure-of-eight bandage of the elbow.

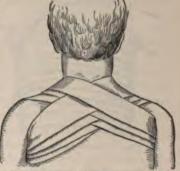


Fig. 747.—Posterior figure-of-eight of both shoulders.

Figure-of-eight bandages of the elbow, both shoulders (posterior figure-of-eight), the neck and axilla are shown in Figs. 746, 747, and 748. A figure-of-eight of the breast is shown in Fig. 753.

Velpeau's Bandage.—Take a roller two and a half inches wide and

ten yards long. Place the palm of the hand shoulder of the sound side, interposing cotto side. Start the bandage at the axilla of the it across the back to the shoulder of the injurarm and under the arm just above the elbow, r repeat this turn, but, on reaching the axilla the and pass around the chest, including the arm

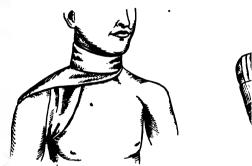


Fig. 748.-Figure-of-eight of neck and axilla.

each alternate turn going over the injured clacification circling the arm and the body, the first turns a ascending (Fig. 749). Pin the crossed piece fracture of the clavicle.

Desault's Apparatus.—This apparatus and a sling. Each roller is two and a half incl



Fig. 750.-Desault's bandage, first roller.

Fig. 7

The pad, which is wedge-shaped, is inserted up. The first roller is used to hold the pad (binds the arm to the side over the pad. This is the weight, the arm is the lever, and the sec the inward deformity of a fractured clavicle corrects the downward and forward displaces of the sound side anteriorly, crosses the chest

side, runs down the back of the arm, around the elbow, and crosses the chest to the point of origin, forming the anterior triangle; it is now carried through the axilla of the sound side to the back, crosses the back to the shoulder of the injured side, runs down the front of the arm, around the elbow, and across the back to the axilla of the sound side, forming the posterior triangle (Fig. 752). The formula for the Desault bandage is: start in the axilla of the sound side anteriorly, run from the axilla to the shoulder, from the shoulder to the elbow, from the elbow to the axilla, and pass to the back; from the axilla to the shoulder, from the elbow to the axilla, and pass to the front. Pin the crossed pieces and hang the hand in a sling (Fig. 752).

Recurrent Bandage of the Head.—Take a roller two inches wide and six yards long. Make two circular turns horizontally around the forehead and head; when the middle of the forehead is reached, catch the bandage, take a half turn, carry the bandage to the occiput, let an assistant catch it, take a half turn, bring the roller forward to the forehead, covering a portion of the preceding turn; continue this process until the scalp is well covered;



Fig. 752.—Desault's bandage, third roller.



Fig. 753 .- Figure-of-eight bandage of the breast.

terminate with two circular turns around the forehead and head (Fig. 754). It is often advisable to take a turn around the head and chin. Pin the crossed pieces.

Recurrent Bandage of a Stump.—Take a roller two inches wide and six yards long. Make two light circular turns around the root of the stump; make recurrent turns covering the stump as is done in covering the head; take a circular turn around the root of the stump, oblique turns to the top of the stump, circular turns around the tip, and apply an ascending spiral reversed bandage (Fig. 755).

T-Bandage of the Perineum.—Pass the transverse part around the body above the iliac crests, and pin it in front; bring one of the tails over the dressing and up between the thigh and the genitals of one side, and the other tail over the dressing and up between the thigh and the genitals of the opposite side; secure these tails to the horizontal band.

Handkerchief Bandages.—Take unbleached muslin one yard square. The muslin folded once makes an oblong bandage; bringing its diagonal angles together makes a triangle bandage; a cravat is formed by folding a

triangle bandage from summit to base; a cor triangle makes an admirable sling.

Fixed Dressings.—Plaster-of-Paris Bar with a cotton or flannel bandage or with a wor roller infiltrated with plaster and place it endw the water covering the plaster. When bubble bandage and apply it without much tension, as a moistened hand. As each bandage is taken one into the water. Apply four thicknesses of ling by sprinkling dry plaster over the bandag hands. The ordinary plaster will set in from it is desired to have it set more rapidly, put a pint of water used; if to have it set more slowly, The plaster bandage is removed by sawing it ding with dilute hydrochloric acid and then culine with a strong knife. Gigli has devised a



Fig. 754.-Recurrent bandage of the head.

Fig.

enables us to remove the dressing with ease. around the limb. A piece of parchment pay shaken out is placed over the cotton. A core upon the paper in a position corresponding to through the plaster. Apply the plaster bands the cord project beyond the bandage. When d take a steel wire, make nicks on one side of it the string to the wire. Pull the wire under the of the wire to a wooden handle and saw through

Silicate of Sodium Dressing.—Protect the bandage. Bandage the limb loosely with an o this bandage with silicate of sodium, apply a and so on until six layers are applied. Gai ordinary bandages to take up silicate of sodiu from twelve to eighteen hours to dry, and the with warm water and then cutting.

<sup>\*</sup> La Semaine Méd., Nov. 3

## XXXV. PLASTIC SURGERY.

PLASTIC surgery includes operations for the repair of deficiencies, for the replacement of lost parts, for the restoration of function in parts tied down by scars, and for the correction of disfiguring projections. Many reparative operations have been devised. Among them are: cheiloplasty, or the construction of a new lip; the closure of a cleft in the palate, the lip, or the penis; the making of a new nose; skin-grafting; grafting of muscle or tendon; nerve-grafting; the introduction of celluloid or metal into the tissues to act as supports; the injection of paraffin into the tissues to amend a de-



Fig. 756.—Injury caused by crush and burn. Healed by granulation in eight months. Showing a condition after removal of scar of the palm, which has been repaired by stitching in an autoplastic graft (free flap) from the thigh (Geo. S. Brown).

pression; the diminution in the size of a lip or a nose; the amendment of protuberant ears; the correction of distortion due to cicatrices; excision of scars; closure of congenital sinuses and of fistulæ; removal of disfiguring growths.

The subject of plastic surgery is very extensive, and a treatise upon it should be consulted if one wishes to obtain detailed and comprehensive information.

A plastic operation can be successful after lupus only when the disease has been cured. It is useless to do a plastic operation during active syphilis,

and a plastic operation for a syphilitic loss of substance is to be performed only after the patient has been thoroughly treated and the disease has been apparently cured. The first step of a plastic operation consists in making the surfaces which are to be brought together raw; the second step is the complete arrest of bleeding; the third step is the approximation of the surfaces without tension; the fourth step is to close any gap from which tissue may

Fig. 757.—Claw-hand from burn. A flap with a pedicle was taken from the chest. The pedicle was cut on ninth day.

have been transplanted; and the final step is the application of the dressings.\* The following are the methods used:†

Displacement is the method of stretching or of sliding: (1) approximation after freshening the edges (as in harelip); (2) sliding into position after transferring tension to other localities (linear incisions to allow of stretching of the skin over large wounds). Interpolation is the method of borrowing material from an adjacent or a distant region or from another person: (1) transferring a flap with a pedicle, which the is put in place at once or is gradually gotten into place by a series of partial operations (as in rhinaplasty, when a flap is taken from the forehead); (2)

transplanting without a pedicle, which is performed by placing in position and by fixing there portions of tissue recently removed from the part, from another part of the same individual, or from a lower animal (as replacement of the button of bone after trephining, transplanting a piece of bone from a lower animal to remedy a bone-defect in a human being, or the grafting of a piece of nerve from a lower animal or an amputated human limb to remedy a loss of nerve in a human being in nerve-grafting, or skin-grafting). Rement is the removal of redundant material and the production of cicatorial contraction.

Skin-grafting.—As long ago as 1847 Dr. Frank Hamilton partly covered an ulcer with a pediculated flap, and trusted that the uncovered portion would be healed by new skin from the flap. We may graft small pieces of epithelium taken from the patient, or another person, or one of the lower animals or we may graft large pieces of epithelium. The grafts should, if possible come from the person to be grafted. The epidermic scales may be scraped

off the sound skin and grafted. Lusk has blistered the skin with cantharides and grafted portions of the epidermis. The shavings of a corn have been used. The best plan is to cut off and transplant small bits of epidermis.

Grafts may come from another person or from a lower animal, but such grafts are not so apt to grow as grafts obtained from the individual, and even when they do grow, fail to furnish a secure cicatrix. Frog-skin furnishes unsatisfactory grafts. Some surgeons have used bits of sponge; others the skin of rabbits, guinea-pigs, or pups. Arnot has employed the lining membrane of a hen's egg, cut in strips and applied upon the wound with the shell-surface uppermost. Small bits of epidermis taken from a recently ampu-

tated foreskin or leg may be used.

Reverdin's Method.—This operation was devised by Reverdin in 1869. Small bits of epithelium are used and they are taken preferably from the person himself. The surface to be grafted should possess healthy granulations level with the skin. Cleanse the skin from which the grafts are to come, the ulcer, and the skin about it, and, if corrosive sublimate is used, wash it away with a stream of warm normal salt solution. Thrust a sewingneedle under the epidermis to raise it, cut off the graft with a pair of scissors, and place the raw surface of the graft upon the ulcer. After applying a number of grafts, place thin pieces of gutta-percha tissue over them and extending on each side of the ulcer, and so placed as to have distinct intervals between them, the gaps permitting drainage. This tissue, after being asepticized, is moistened with warm normal salt solution. Dress with a pad of aseptic gauze moistened with salt solution; place over this gauze a rubber-dam, and over the latter absorbent cotton and a bandage. In the case of children apply a light silicate bandage. Put the patient in bed. In forty-eight hours remove all the dressings except the gutta-percha tissue, irrigate with normal salt solution, and reapply the dressings. All signs of the grafts will often have disappeared. In a day or two, at the site of grafting, bluish-white spots should appear, which are islands of epidermis. Each graft is capable of forming about half an inch of cicatrix. Grafting also stimulates the edges of the ulcer to cicatrize and contract. At the end of seven days the special dressings can be dispensed with. The spot from which the grafts are taken is dressed antiseptically. Reverdin's method does not limit cicatricial contraction to any great degree, and the new skin is apt to break down.

The Ollier-Thiersch's Method.—Ollier, of Lyons, in 1872 succeeded in transferring large pieces of epidermis. In 1886 Thiersch, of Leipzig, set forth the technic practically as it is employed to-day. The Ollier-Thiersch method is performed as follows: Thoroughly asepticize the ulcer, the surrounding skin, and the site from which the graft is to come (the inner side of the arm or the thigh), and wash away the mercurial preparation with normal salt solution. Apply dressings wet with salt solution. On bringing the patient into the operating-room remove the dressings from the ulcer, scrape the ulcer and its edges, irrigate with salt solution, and compress to arrest hemorrhage. Grafts are then obtained by putting the prepared skin upon the stretch and cutting strips with a razor. While the razor is being used the part is constantly irrigated with salt solution. Mixter's apparatus enables one to perform this operation with great neatness and speed. This apparatus consists of a knife and an open square with sharp points on the under surface.

The square is forced down upon the front of the up in the opening to above the level of the me be cut with ease. The graft contains the epi the true skin. In Halsted's clinic the skin of pressing upon it with a piece of asepticized wo along, and is followed closely by the sharp cacuts long grafts. The grafts are pressed into and each graft overlaps a little the edges of grafts. The skin-wound is dressed antiseptic dressed as in Reverdin's method. Recently it ring of aseptic gauze be made to encircle the and another ring above the grafted area; on the wrapped in aseptic gauze are so laid as to me cage the dressings are applied (moist chamber p

Wolfe's Method.—It was pointed out by W of skin, comprising the entire thickness of that transplanted without a pedicle. The ulcer is e bleeding is arrested. The flap is cut one-sixt be covered. Fat is kept out of the graft. T



Fig. 758.—Mayer's dressing for Thiersch's method of skin Surgery").

the wound, the edges of the graft being brough area. It is not necessary to employ sutures. The chamber. If the graft perishes, remove it.

Subcutaneous Injection of Paraffin — The principle of injecting solidifying oils into effects was first laid down by J. Leonard Coparaffin was introduced by Gersuny to amend nose. It has been used to limit incontinence of in women, to prevent reunion of nerves after to obliterate smallpox marks, to narrow a her of the cheek after removal of the upper jaw, at kowicz, in "Wien. klin. Woch.," June 20, Its injection may produce some swelling and cold quickly control inflammation. In two or comes hard like cartilage and encapsuled. In not it is subsequently destroyed and replaced to times sloughing takes place in the skin above it.

Prepare the paraffin as follows: In Gersuny's with liquid paraffin. The melting-point of the F. It is rendered sterile by boiling, is injected a semisolid, the skin having been first warmed by a hot sponge. After injection it is molded into proper shape. It sets in half a minute. It is not wise to use a mixture with a much higher melting-point, because it would possibly cause thrombosis of veins. There are difficulties and even dangers in the use of paraffin for saddle-nose. It should only be used when the skin is loose and elastic. It should never be used if there is great deformity, because then the amount required would surely cause dangerous tension. It is difficult to prevent the injected material from passing down the sides of the nose and up into the forehead. Cases of embolism causing blindness have been reported. The skin may slough if the injection is too hot or if it produces much tension.

Correction of Saddle-nose by the Insertion of a Plate.—Saddle-nose is a condition in which the bones and cartilages have been destroyed by ulceration or collapsed by injury. It is useless to attempt correction by skin flaps alone. Paraffin injections (page 1262) may be used in the less severe cases. In a bad case we must transplant bone flaps or insert a plate for sup-



Fig. 759.-Indian method of rhinoplasty.

Fig. 760.—Italian method of rhinoplasty.

port. The bone-flap operation is seldom satisfactory and of necessity creates a hideous scar. The insertion of a plate may give an excellent result, although the future is always uncertain. In 2 cases I have seen sloughing occur over the plate months after the operation. In one of these cases the sloughing was due to a blow from a cow's tail.

The plate used may be of silver, gold, or celluloid. An incision is made to permit the insertion of the plate. I agree with Leonnard Freeman ("Annals of Surgery," August, 1907) that the incision along the bridge and the incision in the septum below the tip are both objectionable. The first leaves an unsightly scar and does not allow for stretching of the skin. The incision at the tip gives unsatisfactory access to the tissues requiring separation and is liable to infection from the nostril.

The best incision is Freeman's. This is a short incision across the root of the nose between the eyes. The skin is undermined along the bridge to the tip and along the sides. The undermined skin can be stretched if necessary. Rhinoplasty.—The complete operation may be performed by transferring a flap from the forehead. This is known as the Indian operation. It was employed for centuries in India, and interest in it was awakened in England about 1820 by Mr. Carpue. The edges of the defect are made raw. A model of the desired nose is made out of gutta-percha, and its outlines are marked upon the forehead, and the cut is made one-quarter of an inch outside of the outline so as to allow room for retraction. The flap is turned down and sutured in place (Fig. 759), care being taken not to cut off the blood-supply in the pedicle. Plugs of gauze or tubes are inserted to support the flap.

The complete operation can be performed by the Italian method (Taglia-cotian method). This method was first described in Tagliacozzi's book, which was published in 1597. In this operation the flap is marked out on the arm, is made twice the size of the desired nose, and is left attached by a broad pedicle. The nasal surface is rendered raw at proper regions, and the flap is sutured in place, the hand being held upon the head by a special apparatus (Fig. 760). The raw surface upon the arm is dressed. In about three weeks the flap is cut loose from the arm, and is pared and

corrected as may be necessary.

The operations for harelip and cleft palate, and plastic operations on muscles, nerves, tendons, and bones, are considered in other portions of the work.

## XXXVI. DISEASES AND INJURIES OF THE GENITO-URINARY ORGANS.

Hematuria.—By this term is meant the voiding of bloody urine or of pure blood, the blood arising from any portion of the urinary apparatus, and the condition being a symptom and not a disease. Hematuria may be a symptom of disease or of injury of some part of the urinary system, of blood-disorganizations (purpura, scurvy, or variola), or of metallic poisoning (mercury, lead, or arsenic). The color of the urine in hematuria may be anything between a light red and a decided black, but these colors may be produced by agents other than blood. Senna and rhubarb make urine red; carbolic and salicylic acids, brown or greenish-black; beet-root and sortel, the color of blood; methylene-blue, blue. In jaundice, melanosis, and splenic fever the urine becomes brown. Be sure that bloody urine in the female is not due to admixture with menstrual blood.

Tests for Blood.—Spectroscope Test.—Bloody urine, if fresh and diluted with water, shows the two absorption-bands of oxyhemoglobin. The addition of ammonium sulphid causes the two bands to give place to the band of reduced hemoglobin. If bloody urine stands for some time, the

four bands of methemoglobin are discovered (v. Jaksch).

Heller's Test.—Add potassium hydrate to the urine, and boil; a red precipitate of earthy phosphates and hematin forms. Throw the precipitate upon a filter and treat it with acetic acid; a red solution is produced, which soon fades.

Rosenthal's Test.-Take the precipitate from caustic potash, dry it,

and test it for hematin; put some of the dry sedament on a slide, add a crystal of common salt, apply a cover-glass, and cause a few drops of glacial acetic acid to flow under the glass; warm, but do not boil. Teichmann's crystals will appear on cooling.

Struve's Test.—Test the urine with hydrate of potassium, and add acetic acid in excess; a dark precipitate forms, which will yield crystals of hematin

when treated with sal ammoniac and glacial acetic acid.

Almen's Test.—Take 10 c.c. of urine, and pour upon its surface a mixture of equal parts of tincture of guaiac and old oil of turpentine; at the point of junction of this fluid with the urine there forms a white ring which turns blue.

Microscopic Test.—The microscope shows numerous corpuscles except in a very alkaline urine, when but few corpuscles may be found.

In hemoglobinuria—a condition sometimes occurring in burns, acute maladies, and metallic poisoning—there is present blood-coloring matter, which is shown by Heller's test and by Almen's test. The spectroscope shows methemoglobin. The microscope shows no corpuscles or only a few, but

discloses masses of pigment.

Bleeding from the Kidney-substance.—Bleeding from the pelvis of the kidney and from the ureter may be due to inflammation, congestion, contusion, stone, vicarious menstruation, hemorrhagic diathesis, powerful diuretics, fevers, purpura, tumors, catheterization of the bladder, etc. Blood is thoroughly mixed with the urine, and no sediment forms (smoky urine). The corpuscles are profoundly altered, are devoid of coloring-matter, and show pale-yellow rings. The severity of the hemorrhage is measured by the number of the corpuscles. Von Jaksch states that the diagnosis between renal and ureteral hemorrhage rests on the nature of the casts and the epithelium present. From the pelvis of the kidney and from the ureter comes small epithelium, the cells from the superficial layers being polygonal or elliptical, those from the deeper layers being oval or irregular. In hemorrhage from the ureter the cells are few; in hemorrhage from the pelvis they are plentiful and rest upon one another like "tiles on a roof" (v. Jaksch). Cells from the tubules of the kidney are small, granular, and polyhedral, have large nuclei, and are often so arranged as to form cylinders (epithelial casts). The urine during and immediately after a renal hemorrhage is apt to be acid unless alkalies have been administered, unless the bleeding has been severe, or unless pus is present in the urine. A very large renal hemorrhage may cause the passage of almost pure blood. In renal hematuria there are aching in the loin, numbness of the corresponding leg, and often renal colic. The use of the cystoscope enables the surgeon to determine if the hemorrhage is vesical or renal, and if it comes from one or both kidneys. If the bladder-fluid is kept clear, the blood can be seen flowing out of the ureter of the damaged organ, or if both ureters are catheterized a sample of urine can be obtained from each kidney.

**Ureter-catheterism.**—Catheterization of the ureters may give information of the greatest value. It enables the surgeon to obtain the urine from one kidney unmixed with urine from the other kidney and uncontaminated by material from the bladder or urethra. By this method we can determine if pus, blood, bacilli, etc., come from the ureter or kidney, and from which

ureter or kidney. A stricture or a calculus of a ureter can be located; hydronephrosis and pyonephrosis can be diagnosticated; the presence of both kidneys, and if either kidney is diseased or if both are diseased, and the secretory capacity of each kidney in a given time, can be ascertained. The method is also employed to treat various conditions of the ureter and kidney.

Kelly impressed upon the profession that the ureters in women can be catheterized, when the patient by the knee-chest posture permits the atmospheric distention of the bladder, so that the ureteral orifices can be inspected through a speculum. Light is reflected into the speculum, a forehead mirror and an electric light being employed. It may be necessary to dilate the ureter before inserting the speculum. It is rarely necessary to give a general anesthetic. Kelly moistens a bit of cotton wrapped on a metal rod in a



Fig. 761,-Nitze's instrument in use (" Berl. klin. Wochen.").

ro per cent. solution of cocain, introduces it just within the external urehral orifice, and holds it there for five minutes before beginning the operation. When the ureteral orifice of one side is found by inspection through the speculum, he introduces a sterile flexible silk catheter lubricated with boroglycerid and it is pushed up from four to six inches in the ureter. A similar tube is introduced into the other ureter and the separated urines are collected in test-tubes. (See Kelly's "Operative Gynæcology.") The catheterization of the ureters by this method can be performed only by a dextrous and experienced man; but such an individual can do it with ease and celerity; as practised by Kelly himself, it seems, until one tries it, the perfection of simplicity.

Kelly has catheterized the ureter in man by inserting a straight speculumplacing the patient in the knee-chest position to inflate the bladder with air, and introducing a metallic catheter. For a discussion of the technic of catheterizing the ureters see Cystoscopy, p. 1297.

Segregation of Urine.—Professor Harris, of Chicago, has devised an excellent instrument (Fig. 762) which in many cases greatly simplifies the

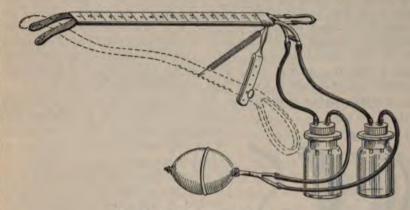


Fig. 762.-Harris's instrument fitted for use.

problem of obtaining unmixed urine from each ureter. The double catheter is passed into the bladder. The lever is inserted in the rectum of the male and the vagina of the female. The lever is fastened to the perforated frame from the double catheter. The double catheter is now opened in the bladder, and the blades of the instrument are held in position by a spring. The end of the lever in the vagina or rectum humps up the floor of the bladder

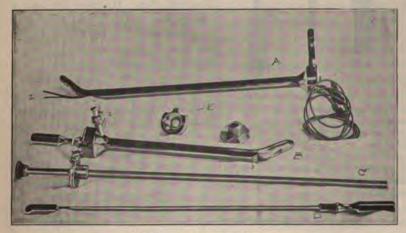


Fig. 763-Lewis's ureter-cystoscope.

between the separated ends of the divided catheter, and forms a longitudinal septum or watershed between the ureteral orifices. The end of each catheter lies in the bottom of a pocket in the side of the watershed. "By producing a very slight exhaustion of the air in the vials by means of the bulb, the urine

1268

as fast as it escapes from the ureters, drops catheters and flows at once into the vials, right

In using this instrument, place the patient the thighs and legs being flexed, and the fee same level. Irrigate the bladder thoroughly 150 c.c. of fluid in the bladder when the binstrument in place for thirty minutes. It anesthetic. In some cases cocain must be use cystitis ether should be given. Harris says used if there is a growth of the bladder the is contracted, or if there is a very large prosta

In catheterization of the ureters there is a

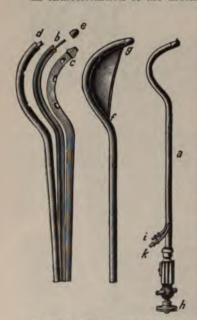


Fig. 764.—Luys' separator: a, The composite instrument ready for introduction; i and k, discharge tubes; h, screw to regulate the tension of the membrane; b, flat middle piece; e and d, grooved lateral portions; e, tip uniting the parts; gf, rubber membrane, tense. The chain is not visible in the figure (Sahli).

infection sometimes It is im blood or if inflamn one or bo method o erable pai As a ma method o certainty, be perfec sometimes the other Luys in cates (Fig accomplis the instru Barringer March 1 are certai separator following: der capac in which the instru the base torted by phy; (b) flexion of

tumors; and (d) marked cystocele." Cathete safe as separation, is far more difficult, but gi

Vesical hemorrhage, including hemmay follow the relief of retention of urine, may tumors, etc., or may arise from traumatisms, it

<sup>\*</sup> Jour. Cutan, and Gen.-Urin. I † M. I. Harris, in Medicine, Apr

color of the urine is usually bright red, but if long retained in the bladder it becomes black and often tarry. The reaction is alkaline. The clots, when floated out, are large and without definite shape. In micturition the urine is clear or only a little colored at the beginning, but becomes darker and darker as micturition ends, at which time the flow may consist of almost pure blood. In very small vesical hemorrhages the urine may be smoky. Crystals of triple phosphate indicate bladder disorder. The microscope shows colorless and swollen corpuscles and many polygonal cells. Symptoms of bladder mischief usually exist, but cystoscopic examination or exploratory suprapubic cystotomy may be required for the diagnosis.

Urethral Hemorrhage.—In urethral bleeding blood appears independently of micturition, or blood comes out first and is followed by clear urine. Urethral hemorrhage arises from acute urethritis, from an inflamed stricture, from the passage of an instrument, or from some other traumatism.

The source of urethral hemorrhage can be ascertained by the use of the

endoscope.

Pain in Genito-urinary Diseases.—Pain as a symptom of genito-urinary disease may be found at some point distant from the seat of lesion. A stone in the bladder causes pain in the head of the penis just back of the meatus; stone in the kidney induces pain in the loin, the groin, the thigh, and the testicle; inflammation of the testicle causes pain in the line of the cord in the groin. In other cases of genito-urinary disease pain is felt at the seat of lesion, as in urethritis and prostatitis. Pain felt before micturition, and being relieved by the act, is found in cystitis and in retention of urine. Pain is felt during micturition in inflammation of the bladder, prostate, and urethra, and in the passage of gravel or stone. Pain which is acute at the end of micturition is noted in stone in the bladder, in inflammation of the neck of the bladder, and in inflammation of the prostate gland. The pain of stone in the bladder, it may be observed, is ameliorated by rest and is aggravated by exercise. The pain of acute prostatitis is intensified by defecation.

Frequency of Micturition.—Frequent micturition arises from irritation of the sensory nerves, from phimosis, contracted meatus, inflammations, very acid urine, calculi, urethral stricture, and hyperesthesia of the urethra. Frequency of micturition may be due to spinal irritability from concussion or from sexual excess, from contraction of the bladder rendering the viscus unable to hold much, from worry, anxiety, fear, or from excessive urinary secretion, as in diabetes or in the first stage of contracted kidney. Frequent micturition exists in obstruction by enlarged prostate and in atony of the bladder-walls. Hypersecretion of urine plus bladder intolerance is known as "nervousness," and is found in hysteria. Frequency of micturition increased by movement is observed in stone and tumor of the bladder. Nocturnal frequency of micturition is present in cases of enlarged prostate and atony of the muscular walls of the bladder. Frequency of micturition with diminution of stream-caliber suggests a constriction of the urethral diameter; frequency of micturition with diminished force suggests a posterior stricture, enlarged prostate, or bladder atony. Slowness of micturition hints at enlarged prostate, atony, or urethral stricture.

Sir Henry Thompson's diagnostic questions are as follows:

"1. Have you any, and, if so, what, frequency in passing water? Is quency more manifest during the night or the day? Is frequency manifest during motion or rest? Does any other circumstance affect it?

"2. Is there pain on passing urine, and, if so, is it before, during, or after the act? What is its character—acute, smarting, dull, transitory, or continuous? What is its seat? Is it felt at other times, and is it produced or intensified by sudden movements?

"3. What is the character of the stream? Is it small or large; twisted or irregular; strong or weak; continuous, remitting, or intermitting? Does it

come by the meatus, or partly or entirely through fistulæ?

"4. Is the character of the urine altered? What is its appearance, color, odor, reaction, and specific gravity? Is it clear or turbid, and, if turbid, is it so at the time of passing? Does it vary in quantity? Are the normal constituents increased or diminished? Does it contain abnormal elements, as albumin or sugar? What inorganic deposits are found? What organic materials are met with?

"5. Has the urine ever contained blood? If so, was the color brown or bright red; were the blood and urine thoroughly mixed; was the blood passed at the end or at the beginning of micturition, or did it come only with the last drops of urine; or was it passed independently of micturition?

"6. Inquire as to pain in the back, loins, and hips, permanent or transitory, and for the occurrence of severe paroxysms of pain in these regions."

The Determination of the Excretory Capacity of the Kidneys in Health and in Disease. The Phloridzin Test. This test is made with comparative ease and often aids the surgeon in determining whether he is justified in performing some operation of convenience. It enables him to estimate with a fair amount of accuracy the capacity for elimination possessed by the kidneys. The test depends on the fact that the healthy epithelium of the glomeruli and tubes, when stimulated to activity by phloridzin, forms sugar from that drug and thus produces temporary glycosuria. When the epithelium is diseased, little or no glycosuria occurs. The test is applied as follows: The dose is about 5 to 10 milligrams of phloridzin, according to the body-weight of the patient. It is administered hypodermatically, the bladder having been emptied beforehand. If the eliminating powers of the kidney are at a healthy level, sugar should appear in the urine within half an hour of the injection. If at the end of this time only a small amount of sugar can be detected, one may assume that the kidneys are affected; and if no sugar can be found, a serious renal disease may be assumed to exist.

The actual standard that is to be considered as the normal amount of sugar which should be eliminated after the administration of phloridzin is a matter of some uncertainty. It is usually estimated at 0.3 per cent., a less amount of sugar than this being taken as an evidence of renal difficulty (Watson and Bailey, in "Report of Boston City Hospital for 1902"). The sugar is separated from the phloridzin in the epithelium of the glomeruli and tubules of the cortex of the kidney. The drug seems to be entirely harmless.

It is because phloridzin is acted upon by the kidney-epithelium that this test is better than the methylene-blue test. The latter does not really measure the excretory power of the kidney-epithelium: it merely shows to what degree

the kidney is permeable in the mechanical sense. Personally, I should not be disposed to set aside older and more thorough methods of urinary analysis for the phloridzin test, although I believe that it has a range of distinct usefulness.

The Methylene-blue Test (The Method of Achard and Castaign).—When methylene-blue is injected hypodermatically it normally appears in the urine within half an hour and disappears in from thirty-six to forty-eight hours. If the blue color is not manifest in the urine for an hour or more, there is impairment of renal permeability. Accuracy in the test is not possible unless the amount of the methylene-blue actually passing into the urine in a given time is determined. The dose given hypodermatically is 0.05 gm. in 1 c.c. of sterile water. The test is unreliable and the blue color may appear in the urine in half an hour in some cases of marked kidney disease.

Cryoscopy (Korányi's Method).—Cryoscopy is the determination of the freezing-point of a liquid and the comparison of this with the freezing-point of distilled water. It is applied particularly to blood and urine. This method is complex and difficult of application, and requires a considerable amount of fluid. The freezing-point of a fluid depends upon the number of molecules it contains. The freezing-point goes hand in hand with molecular concentration—great concentration gives a low freezing-point, little concentration a high freezing-point. Cryoscopy of the blood and urine is used to determine the adequacy of renal activity. Normal blood freezes at about —0.56° or —0.57° C. Healthy urine freezes between —0.9° and —2° C. In renal inadequacy the freezing-point of the blood is lower than normal and the freezing-point of the urine is higher. It is held that surgical operation is contraindicated if there is such a degree of renal inactivity that the freezing-point of the blood is at or below —0.6° C. and if the freezing-point of the urine is at or above 1° C.

## DISEASES AND INJURIES OF THE KIDNEY AND URETER.

Tumors of the Kidney.—Tumors, innocent or malignant, may arise in the kidney. Among the innocent tumors are fibroma, lipoma, angioma, and adenoma. Hypernephroma of the kidney arises from fragments of adrenal tissue included in the kidney. They were thought to be renal lipomata until 1883, when Grawitz showed they contained adrenal elements ("Virchow's Archiv.," xciii). The name hypernephroma was suggested by Birch-Hirschfeld in 1806. A hypernephroma may arise directly from the suprarenal gland or it may arise from an adrenal "rest" or aberrant gland. Such rests may be met with in the substance of the kidney, under the renal capsule, in the perirenal tissue, in the testicle, the ovary, the liver, the inguinal canal, the mesentery, among the spermatic vessels, in the broad ligament, in the renal plexus, or in the solar plexus (W. W. Keen). The term hypernephroma is applied to any growth which arises from adrenal cells "whether the growth be adenoma, carcinoma, or sarcoma in type" (Duffield in "N. Y. Med. Jour.," May 1, 1909). The tissue of a hypernephroma is identical with the adrenal gland, and it contains fat and glycogen. The exact nature of such a tumor is unsettled. It is probably an adenoma, but some consider it to be a sarcoma and others a carcinoma. Some tumors give no evidence of malignancy; some are very

malignant. A malignant hypernephroma groattains a large size, and is sometimes painfu Hospital from whom I removed a hypernephr in the left side and occasional attacks like rena bloody urine. The tumor could be easily pakidney was removed and resembled a huge kidn nodular in outline. Dr. Coplin found it to be there was no increase of arterial tension. The was a woman of forty-five, who was brought thad suffered from pain in the loin for months.

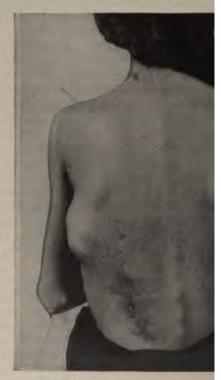


Fig. 765.-Sarcoma of kidney with me

the radiation of renal colic. Hematuria apperbegun. It was persistent, but small in amount and the x-rays showed enlarged kidney. The tension. Recovery followed nephrectomy. proved fatal within six weeks after symptoms whave lived three years. A hypernephroma adjacent structures, and gives rise, after a time way of the blood. The bones are most liable to deposits may occur in the lungs, liver, and of which I operated for a supposed adenomatous metastatic hypernephroma. Hypernephromata

in the kidney than anywhere else. They tend particularly to occur in middle life. Sarcoma or carcinoma may arise in the kidney. Sarcoma is most common in the young, and may reach an enormous size (Fig. 765). A malignant tumor of the kidney produces hematuria, the urine often containing blood-casts of the ureter, kidney, and pelvis, and sometimes, though rarely, characteristic cells. Pain is often present in the loin and thigh, and there may be colic-like attacks when clots are passing through the ureter. Emaciation is rapid and pronounced. A tumor can usually be palpated. The only possible treatment for a malignant growth is early nephrectomy. In some few cases an innocent tumor can be removed by a partial nephrectomy. A malignant tumor requires a complete nephrectomy. In making a diagnosis of renal tumor use the cystoscope. If blood is coming from a ureter, note if it is from only one or from both. Blood from both would contraindicate nephrectomy. Before removing a kidney it is necessary to be sure that the patient is possessed of two kidneys. Note if urine flows from each ureter, or, if uncerain, catheterize the ureters.

Nephroptosis, Prolapse of the Kidney, or Mobile Kidney.— There are two forms of this condition: (1) Movable kidney, which is an organ reely moving back of the peritoneum, either within the cavity of its fibroatty capsule or entirely without its capsule (this condition is acquired); and (2) floating or wandering kidney, an organ having a mesonephron and lying within the peritoneal cavity (this rare condition is always congenital). Keen states that there may be drawn a clear theoretical distinction between movable and floating kidney, but practically there is no rigid line of demarcation, as a movable kidney may have as large a range of movement as a floating kidney. The kidney is normally somewhat mobile, and nephroptosis is considered to exist only when the range of movement exceeds distinctly what is normal. Normally, on inspiration the kidney descends about half an inch. It is seldom that a normal kidney can be palpated in men, but in most women the right kidney can be palpated, and in some women the left organ can also be felt. Harris ("Jour. Amer. Med. Assoc.," June 1, 1901) describes three degrees of movable kidney. In cases of the first degree, one-half of the organ can be distinctly grasped and the kidney can be made to recede. In cases of the second degree both hands can be brought together above the kidney. In cases of the third degree the kidney has descended as low as the pelvic brim or has moved to or beyond the umbilicus. The organ may drop below the brim of the pelvis, may cross the vertebral column, or may reach the anterior abdominal wall. When a movable kidney becomes fixed in an abnormal situation, the organ is spoken of as dislocated.

Women suffer from movable kidney more often than do men. Küster estimates that 4.41 per cent, of women examined in general surgical practice have movable kidney. Edebohls finds it in 20 per cent., and Harris in 56 per cent., of cases in gynecological practice. In about one-half of the cases it gives rise to little or no trouble. A movable kidney is found in the great majority of cases upon the right side. In many cases it is bilateral, the right kidney being usually the most mobile. Splanchnoptosis may be associated with acquired nephroptosis. Floating kidney is always congenital. The condition is occasionally, but rarely, found in children, though congenital cases occasionally occur. In a congenital case there is not splanchnop-

tosis. Tuffier has reported 3 cases in childred age respectively, and J. Cromby reported 18 can dren, the youngest patient being three month "Jour. Amer. Med. Assoc.," June 1, 1901). The movable condition are to be named trauma laxity from pregnancy, removal of a tumor, of tion of peritoneal fat from wasting disease (Eddisplacements; and enteroptosis leading to tracolon. The condition is certainly often associated abdominal viscera (enteroptosis, gastroptosis,

Traumatism is rarely the immediate and eskidney. In some cases people assert that pa blow, an attack of coughing, violent vomiting in parturition, or a fall. In such cases the before the accident. Again, pain is not proof bility. It is probable, however, that traum: and that mobility may subsequently develop. in normal relations cannot be rendered mobil force. Loosening can be induced only by a and if this happens, symptoms of a distinct n injury. Harris makes out a strong case for due to the relation existing between the locatiform. He divides the body into three zones. lungs and heart. The middle contains the liv and the greater part of each kidney. The lov and the lesser part of each kidney. When t diminished capacity of the middle zone, the k The right kidney is pressed upon by the heav the left kidney is pressed upon by the compa movable kidney is more common on the righ upper pole of the kidney is first pushed forw descends (M. L. Harris, in "Jour. Amer. Harris maintains that the amount of mobilit contraction of the middle zone and upon intering, coughing, etc.).

Symptoms of Both Forms.—There may the patient may be a confirmed invalid. The pain (just to the left of the middle line), which is replaced, dragging pain in the loin, and Sudden attacks of violent pain in the kidney of which are accompanied by nausea, vomiting vertigo, chills, and subsequently elevated temper crises are due to kinking or twisting of the uret mation of the kidney. They may be caused cretion in diet and may be followed by hy of the renal vessels. A few years ago I operate a violent and prolonged crisis and found a temperature of the renal pain in the abdomen and loin, hematuria, alboratoric discontinuous constraints.

The question as to whether or not abdominal pain is due to movable kidney is sometimes in doubt. The localization of the pain may lead us to suspect appendicitis. Some surgeons think that catarrhal appendicitis is often associated with movable kidney, but I do not think the association is common. "Dr. Kelly has shown us how to solve this doubtful question between appendicular pain and the pain of movable kidney. He catheterizes each ureter separately, and introduces into each catheter as much as the renal pelvis will hold without causing pain. He then measures this fluid from each side, and determines whether it is in excess of an estimated average. If it is in excess, he is sure that dilatation has begun. He then injects the kidney again, with the deliberate purpose of producing pain; and if the patient recognizes this pain due to the distention as of the same character and in the same position as that which he has previously felt, Dr. Kelly assumes that the pain has been due to the kidney, and not to the appendix, and recommends an operation to fix the kidney" (the author, in "New York Med. Jour.," August 4, 1906). Usually in a case of movable kidney there is a sense of a moving body in the abdomen, and the patient has aggravated indigestion, often accompanied by vomiting. Constipation is the rule, and violent attacks of cardiac palpitation are common. Most subjects of this kidney mobility are extremely nervous-many of them hysterical or hypochondriacal. Persistent vasomotor paresis causes cold hands and feet and often albuminuria. Temporary jaundice is not uncommon. There is frequently irritability of the bladder. Vertigo and insomnia are present in many cases. The patient cannot sleep when lying on the sound side (Goelet). In women the sexual organs are almost invariably deranged, and menstruation aggravates the pain and discomfort. All the symptoms are intensified by exertion and are modified by rest. The urine is normal, except after violent exercise, when it may contain blood. Splanchnoptosis may also exist, and if it does, the pulsations of the abdominal aorta are strongly noticable because that structure is bared by gastroptosis. The proof of the existence of movable kidney is the finding of a tumor, movable on respiration, change of position, and palpation, shaped like that organ, pressure upon which occasions no sensation or causes pain or a sickening feeling. A "lumbar recess" (Morris) may sometimes be found, and percussion over the loin gives resonance. In some cases a movable kidney can be readily detected when the patient stands up, but is difficult to find when he is recumbent. Franks's method of examination is very satisfactory. The patient is placed recumbent. If dealing with a right kidney, the surgeon stands to the right side and pushes four fingers of his left hand in the loin below the twelfth rib, and rests the thumb lightly in front just below the ribs. The patient takes a full breath and holds it a moment, and just before he empties his lungs the surgeon presses his thumb up deeply below the ribs. During expiration the thumb follows the liver, and the fingers press toward the front. If with the right hand the kidney can be felt entirely below the left hand, the case is one of movable kidney. If such a condition is detected, press hard with the right hand, and gradually loosen the grasp of the left hand, and the kidney will slip between the fingers and ascend. A normally mobile kidney descends so that its lower end can be felt, but it moves back during expiration.\* Goe-

<sup>\*</sup> Brit. Med. Jour., Oct. 12, 1895.

let uses Kendal Franks's method of palpation, but has the patient stand, with the weight resting on the leg of the sound side and with the leg of the impaired side slightly flexed and resting on the toes. The body leans a little forward. A movable kidney must not be mistaken for a distended gall-bladder, a tumor of the mesentery, stomach, or omentum, a phantom tumor, an ovarian tumor, or a cancer of the pancreas. A distended gall-bladder can be pushed upward, but not backward, and not downward unless the liver is movable; it is extremely tender, and cannot be pushed out of reach. A kidney can be pushed upward and backward—in fact, in all directions. An enlarged gallbladder can always be palpated. A movable kidney which is not enlarged can be felt at times and not at others (Henry Morris). A movable kidney may pass between the examiner's fingers, and if pushed into the loin, it tends to remain; but if a distended gall-bladder is pushed into the loin, it springs out as soon as pressure is relaxed (Henry Morris). It is important to remember that in about one-half of the cases of movable right kidney the left kidney is also movable, but to a less degree. Appendicitis is thought by some to be more frequent in individuals with movable kidney than in those who do not suffer from it. Sometimes a movable kidney endangers life, rupture of the kidney, twisting or rupture of the ureter, or strangulation of the renal



Fig. 766.—A. H. Goelet's method of palpation for the detection of a prolapsed kidney.

vessels occurring, the ultimate cause of death being albuminuria, uremia, or hydronephrosis.

Treatment. - Mobile kidney is treated as follows: If the kidney is but slightly mobile and there are no local symptoms, the treatment should be non-operative. (1) The rest-treatment of S. Weir Mitchell may be tried; it often markedly mitigates the symptoms, but does not seem to cure. (3) Mechanical support should always be tried. The most satisfactory mode of applying it is by the corset record mended by Gallant ("Amer. Jour. O" stet.," July, 1901). This corset is low and straight in front, and when applied fits firmly over the hips and lower abdomen, less firmly at the waist, and least firmly above.

Gallant directs that the patient lie down, the head being on a pillow and the knees drawn up. While in this

attitude the corset is put on and it is laced from below up. If the attempt to apply the corset develops tenderness, keep the patient at rest in bed until it can be applied without pain. In some cases conservative treatment is not indicated; in others it fails.

In every case of very movable kidney and in some cases in which movability is not great operation is indicated.

"In a case in which the kidney exhibits trivial movability, but in which

the range of mobility is found to be gradually and certainly increasing, or in any case of kidney movability in which there are distinct local symptoms, operation is indicated. The distinct local symptoms mean the beginning of actual harm to the kidney, and the progressive increase of movability means the ultimate attainment of a wide range of movement. A kidney which is widely movable may at any time twist upon the ureter and the renal vessels; and it is certain to suffer from partial or slight twists, probably many times repeated in the twenty-four hours, even if a severe twist does not occur. A deduction from the foregoing statements is that a patient suffering with nephroptosis, even when the mobility is slight, should be examined at regular intervals, to note whether the area of movement is extending, or whether local symptoms have arisen. Three local symptoms that should be regarded as indications for operation are severe pain in the renal region, distinct tenderness of the kidney, and enlargement of the kidney" (the author, in "New York Med. Jour.," August 4, 1906). Billington ("Brit. Med. Jour.," May 1, 1909) formulates the following indications for operation:

1. When renal pain is so severe or persistent as to cause serious inconvenience. The ordinary dragging pain in the loin is not an indication. Billington refers to severe pain due to perirenal inflammation, ureteral obstruction, or impeded venous return.

2. When there are harassing and depressing gastric and colonic troubles (gross lesions being absent).

3. Cases of spinal and cerebral neurasthenia.

 Cases of lunacy. Personally I do not operate on groups 3 and 4 unless there are signs of grave renal disaster.

The usual operation chosen will be nephropexy, very seldom nephrectomy.

(1) Nephropexy is the operation employed in most instances (page 1293). It is the author's experience that if the patient has had marked nervous symptoms for a long time, nephropexy will rarely cause them to pass away permanently, even though the kidney remains firmly anchored. (2) Nephrectomy is necessary only in very rare cases; it may be done for dislocated kidney, when grave kidney disease exists, or when nephropexy has failed in a case of great severity.

In many cases of this trouble no operation should be performed, the use of Gallant's corset securing, perhaps, decided or complete relief. I do not operate if the kidney is only slightly movable and if there are no local symptoms or if there are merely the general symptoms of hysteria. If the mobility is slight and the hysterical and neurotic condition is pronounced, anchoring the kidney will not cure the nervous condition. In these nervous cases, associated with prolapse of the kidney, there is usually, also, prolapse of the other abdominal viscera; and both kidneys are, as a rule, movable, the right, however, being decidedly more movable than the left.

If there is but slight mobility of the kidney, but the range of movement is, week by week and month by month, increasing, or if we find a case of movable kidney in which there are distinct local symptoms, an operation should be performed. The existence of definite local symptoms means beginning harm to the kidney; and if we find the area of movement gradually increasing, we know that eventually it will become extensive. Any widely movable kidney may twist the ureter and the renal vessels, producing serious trouble

or even disaster, and consequently should be fixed by operation. Even if a severe twist does not take place, it is bound to suffer from partial or slight twists. Such kidneys will eventually become hydronephrotic. The meaning of the term slight mobility is indicated on a previous page (p. 1273).

One is not unusually in doubt in cases of movable kidney whether a pain indicates local trouble with the kidney or catarrhal appendicitis, because the pain may be located in the appendix region. Kelly, of Johns Hopkins

Hospital, has shown how to solve this problem (p. 1275).

There are many operations for movable kidney. In all of them the kidney is exposed in the loin. Some make a vertical and some an oblique incision. Edebohls makes a vertical incision, forces the kidney out of the wound, incises the fibrous capsule longitudinally, turns a cuff down on each side, and applies sutures. These sutures traverse the kidney-substance and the fold of capsule on each side. The upper suture catches the periosteum of the last rib; the other sutures catch the lumbar fascia. Drainage is not required, and the suture material employed is kangaroo-tendon or chromicized catgut.

Many surgeons simply pass sutures through the uncut capsule and the kidney-substance and thus fasten the kidney to the lumbar fascia. Others split the capsule and pass sutures through the edge of the capsule and the

wound-edges, but not through the kidney-substance.

To promise success, an operation ought to restore the kidney nearly we its normal position and fix it permanently in place. It is undesirable to inflict damage on the kidney itself, and I do not believe in any operation that passes sutures through the kidney-substance. In cases in which decapsulation is performed, the kidney will grow fast without any special method of suturing.

Most of the operations suggested do not place the kidney sufficiently high up to get it into a fair position. Kelly's operation gets it higher than most of them, and Goelet's operation gets it well into place. In many of the suture operations the sutures are placed in the convex surface of the kidney of the kidney capsule, and on fixing the kidney by tying the sutures there is a permanent quarter twist of the ureter-a condition that may be responsible for great pain. This may be obviated entirely by the ingenious method of Goelet ("Annals of Surgery," Dec., 1903). I believe, however, that the suture operations which do lift the kidney well up toward its proper place and in which the sutures are applied on the posterior surface and not the convexity, tilt the upper pole forward into a permanent and perhaps disastrous position. Such operations lift the kidney from below its mid-line and thus fix the lower half of the organ, but leave the upper half unfixed. I believe, too, that in many cases in which kidneys have been sutured they get loose again and that the best operation, after all, is that by the use of slings of iodoform gauze (page 1293).

Injuries of the Kidney.-Laceration or rupture is caused by falls

and by blows upon the back or the belly.

Symptoms.—In some cases the parenchymatous structure is torn, but the capsule is not torn, and in consequence urine and blood are not extravasated into the perineal connective tissue or into the peritoneal cavity. In other cases the parenchyma and capsule are both torn and urine and blood are extravasated. The laceration may be trivial, may be considerable, or

may tear the kidney apart. The symptoms depend on the gravity of the injury. A slight tear without involvement of the capsule may produce practically no symptoms at all. A more severe injury produces shock, and, if

profuse bleeding occurs, the general symptoms of hemorrhage. In intraperitoneal rupture there is profuse and usually fatal hemorrhage. In laceration of the kidney there are severe pain in the loin, which shoots into the testicle, and lumbar tenderness. If there is considerable perirenal bleeding, the loin will be full, and dull on percussion, and if the hemorrhage is large, a palpable mass will form after a time and after



Fig. 767.—"Purse-string suture" applied to a perforation (after Schachner).

some days the skin will become discolored. There is frequent and painful micturition and sometimes suppression of urine. Hematuria occurs in renal laceration unless the rupture was intraperitoneal or the ureter was torn, in which case there are evidences of profuse internal hemorrhage, abdominal rigidity, etc. (Daniel N. Eisendrath, "Jour. Amer. Med. Assoc.," Oct. 25, 1902). It is important to remember that hematuria can arise from simple renal contusion, and that kidney damage does not of necessity cause bloody urine. If there is hematuria, the use of the cystoscope or catheterization of the ureters, or the employment of Harris's segregator, will demonstrate from which kidney the blood comes. A kidney-laceration may be followed by secondary hemorrhage, perirenal suppuration, hydronephrosis, or pyonephrosis, and may cause kidney displacement.

Treatment.—In an intraperitoneal rupture laparotomy should be performed because of abdominal hemorrhage. As a rule, nephrectomy is necessary, but it may be possible to arrest hemorrhage by packing. If the shock is pronounced and if there is increasing fulness in the loin, whether hematuria exists or not, or if blood comes profusely from the ureter, whether or not there is much shock or lumbar fulness, make an exploratory lumbar incision and stop the bleeding by packing or by a purse-string suture (Figs. 767, 768), or, if necessary, perform partial, or even complete, nephrectomy. Ordinarily, when there is not great shock, increasing lumbar swelling, or severe hematuria, treat by rest in bed and by feeding with liquid food or by nutritive enemata to prevent vomiting. Opium, tannic acid, or gallic acid may be used. Apply ice-bags to the loin and the side of the abdomen, and after bleeding ceases strap the loin and apply a binder. If large blood-clots in the bladder cause pain or retention of urine, introduce a catheter and inject the bladder with boric acid, or use the tube and evacuator of a Bigelow apparatus. If this procedure fails, open the bladder by a suprapubic incision and drain.

Results of Operation.—Up to 1894 there had never been a case of intraperitoneal rupture operated upon; since then 6 have been operated upon and all recovered (Daniel N. Eisendrath, "Jour. Amer. Med. Assoc.," Oct.

1280

25, 1902). Küster collected 47 cases of n recovered. Keen estimates the mortality of pr at 20 per cent., and of secondary nephrector operation intraperitoneal rupture is inevital operated upon recovered. Of extraperitoneal without operation (Eisendrath). Francis S. Surg. Jour.," July 16, 1903) has collected 66 the kidney. The following statistics are of intecases with 81 deaths, a mortality of 29.6 per other than nephrectomy: 99 cases with 7 dea Treated by nephrectomy: 115 cases with 25 cent.

Perforating wounds of the kidney, if p the peritoneum; if anterior, they do. The

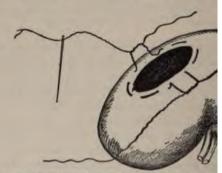


Fig. 768.—Showing the application of a double "purse-string large wound (after Scha

and urine by the wound; hematuria is usual, rupture; the patient may be unable to micture constitutional signs of hemorrhage exist. Trabscess, or general sepsis may ensue. Confir with the finger. Extraperitoneal injuries given bad, prognosis.

Treatment.—If the wound of the kidney lumbar wound to permit of drainage, and arrehot water or by a purse-string suture (Figs. 76 insert a drainage-tube down to the kidney, drawed the patient in bed on a low diet, and give a cases nephrectomy, partial or complete, will be wounds perform an abdominal section and, a organ (see Nephrectomy).

Wounds of the Ureters.—Rupture fr tremely rare accident. There are 3 undoubt Eisendrath, "Jour. Amer. Med. Assoc.," C wound from accidental violence is almost in serious injuries. The ureter may be wounded during the performance of an abdominal ope intentionally, as in Morris's cases, in which a porated with the ureter. There is particular danger of injuring the ureter in operations upon intraligamentary growths, because the ureter is displaced and often resembles an adhesion. The rule of surgery is that when working about the ureter the surgeon neither clamps nor cuts any structure without a careful preliminary examination. Rupture causes severe shock and extravasation of urine around the kidney or into the peritoneal cavity. In extraperitoneal rupture a palpable mass forms in the loin. When the ureter is divided in an operation, a flow of urine is seen.

Treatment.—The upper three-fourths of the ureter can be reached by an extraperitoneal incision, which is a prolongation of the incision for lumbar nephrectomy, running from the twelfth rib downward, and forward to one inch anterior to the anterior superior spine of the ilium, and then parallel to Poupart's ligament until a point is reached above its middle (Fenger). Israel's incision begins at the anterior edge of the erector spinæ mass, one finger's length below the twelfth rib, is taken forward parallel with the rib until it reaches the line of the rib's tip, and is then carried toward the middle of Poupart's ligament until the line for ligation of the common iliac artery is reached, and is then taken toward the middle line as far as the outer border of the rectus muscle. The lower one-fourth of the ureter can be reached by abdominal section or by sacral resection (Cabot), but best by an incision like that for extraperitoneal ligation of the iliac vessels. If it seems probable that the ureter is wounded or ruptured, explore, and if this is found to be the case, endeavor to restore the continuity of the tube. A longitudinal cut can be sutured with fine catgut. If the ureter is cut across near the bladder, implant the proximal end into the bladder and ligate the distal end (Van Hook, Penrose, Kelly). If it is cut above the bladder portion, perform lateral implantation by Van Hook's method (page 1296).

A longitudinal wound of the ureter inflicted during an abdominal operation should be sutured, but if the duct cannot be readily reached, simply make a posterior incision and drain with rubber tissue, as the longitudinal wound will heal by granulation if no sutures are inserted (Van Hook). In a case of transverse division perform uretero-ureterostomy or vesical implantation; or, if neither of these methods is feasible, make a urinary fistula or

perform nephrectomy.

Renal Calculus.—A stone in the kidney is formed by the precipitation of urinary salts into the renal epithelial cells and the gluing together of these salts and cells by material from mucus or blood-clot, this mass serving as a nucleus on which accretion takes place. Most calculi escape when small, as gravel. The cause is a highly acid urine, which induces catarrh of the renal tubes. Such high concentration of urine is favored by a sedentary life, by the ingestion of much alcohol or nitrogenous food, by constipation, by an inactive skin, and by a torpid liver. The children of poverty are liable to calculi because of the use of unsuitable foods and the formation of great amounts of nitrogenous waste. Males suffer more often than do females; certain locations favor the development of the malady, and a family tendency sometimes exists.

Symptoms.—The symptoms of stone in the kidney may not appear for years, but generally they are manifested early. There may be no pain. There had been none in 13 cases out of 24 which came to autopsy and were reported

by Clark. Usually there is pain; the severity of the pain depending upon the roughness and movability rather than upon the size of the stone. A fixed stone in the kidney and a smooth stone in the pelvis may cause little of no pain. A rough stone in the pelvis causes severe pain. The patient usually complains of pain in the loin, and sometimes of pain in the iliac region. Deep percussion over the kidney causes pain in the loin, even when pressure is painless (Jordan Lloyd's symptoms). Pain is aggravated by exercise and pressure, and the kidney is usually enlarged. The urine is often somewhat albuminous, and may from time to time contain blood. Frequency of micturition is noted during the day, but not at night. The urine may be purulent. Nephritic colic is due to the washing of a calculus into the orifice of the ureter, which it blocks, tears, or distends. The pain is either sudden or gradual in onset, is fearful in intensity, and runs from the lumbar region down the corresponding thigh and spermatic cord (the testicle being retracted), and into the abdomen and back. There are nausea, vomiting, collapse, sometimes unconsciousness or convulsions. Frequent attempts at urination are productive of pain, but of little urine. Rectal tenesmus is common. The urine is often, but by no means always, smoky from blood. Blood may be found by the microscope when it cannot be detected by the naked eye. In rare cases fatal hemorrhage occurs. Blood is present in about one-half the cases. After a time the pain vanishes, the stone having passed into the bladder or having fallen back into the pelvis of the kidney. Slight attacks of colic occur from the passage of small stones or of plugs of mucus. A calculus retained in the kidney eventually excites pyelitis, pus appears in the urine, and soreness or pain in the loin exists. Kelly says: Even if pus is found, we are not always sure from which kidney it came. Pain or swelling may point to one side, but we are not sure that the outer organ is not also affected. The cystoscope must be used. Bloody or purulent urine may be seen coming from one ureter. able to pass the renal catheter into one ureter, attach a syringe, and by mak suction, draw out any pus which may be present. In renal calculi cases the fluid is apt to contain fragments of uric acid. By using a renal bougie coat with dental wax it may be possible to make scratches on the instrument whe it comes in contact with a concretion.\* When a stone is impacted in the pelv the point of greatest tenderness on pressure is below the last rib, by the edg of the erector spinæ muscle. In septic cases there may be chills and irregulas fever, and often there is leukocytosis. In most cases a stone in the kidney or ureter can be skiagraphed. Nephrolithiasis may cause death by exhaustion, by sepsis, by rupture of a hydronephrosis, or by amyloid degeneration.

Treatment.—For the gravel of the uric-acid diathesis use alkalies, especially the liquor potassii citratis, and reduce the amount of nitrogen in the diet to a minimum, at the same time washing out the organs by copious draughts of Poland water or Londonderry lithia. Piperazin, in doses of gr. v to gr. viij three times a day, is highly commended. Exercise is to be insisted on. When gravel is phosphatic, order strychnin, the mineral acids, and rest at the seaside. When oxalate of lime is found, restrict the diet, use the mineral acids, recommend travel or rest amid new surroundings, and give an occasional course of sodii phosphas, 3s three times a day, drunk in Buffalo lithia water. Nephritic colic is relieved by hypodermatic injection of morphin and atropin, the hot bath, diluent drinks, or the inhalation of ether-

<sup>\*</sup>Howard Kelly, in Med. News, Nov. 30, 1895.

After an attack use the cystoscope, and if a stone is found in that viscus, wash out the bladder with an evacuator. If a stone impacts in the ureter, perform the operation of ureterolithotomy. The diagnosis of this impaction is in many cases aided by the x-rays, but is sometimes possible only after exploratory laparotomy. If the symptoms point to stone in the kidney, medical treatment having been used without avail, always take a skiagraph. If this shows a stone and if there are no evidences of organic disease of the kidney, operate. If in doubt in spite of the skiagraph, make an exploratory lumbar incision; feel the surface of the kidney with the finger, sound the inside of the organ with a needle, and if a stone is detected, incise the kidney and remove the stone. Keen is of the opinion that operation should not be performed if the urea is below 1 per cent. If, after nephrolithotomy, suppression of urine occurs, cut into the other kidney, as in one-half of all cases a stone will be found lodged there. I agree with Brewer ("Med. Record," March 20, 1909) that "a kidney containing one or more calculi, and also the seat of an advanced septic process, should be removed if the opposite organ is healthy. To leave such a kidney is to invite subsequent trouble from recurrence of stone, pyonephrosis, or longcontinued sepsis." I agree with him when he says: "It is also often safer to remove a kidney with multiple calculi imbedded in its substance than to inflict the trauma necessary to remove them, as alarming primary or secondary hemorrhage is apt to occur." In a recent case of my own a most persistent postoperative hemorrhage forced me to perform nephrectomy to save life.

Calculus in the Ureter.—A ureteral calculus comes from the kidney, sometimes dropping, but more often being forced, into the tube. A stone may be arrested at any one of these points of constriction. There are three points of constriction in the ureter: one point is about 2 inches below the renal pelvis, another is at the pelvic brim, another is about  $\frac{1}{2}$  inch from the bladder orifice of the ureter. The highest point has a diameter of about  $\frac{1}{7}$  inch, the middle point a diameter of about  $\frac{1}{10}$  inch. A small stone may completely block the ureter. A large stone may fail to completely block it because the ureter dilates above, the

stone acts as a ball-valve, and urine trickles by.

Symptoms.—Attacks of violent pain of the nature of renal colic, and not unusually a rigor with the attack and fever after it. Such an attack may be followed by hematuria. The urine should be examined microscopically during several days after a colic to see if it contains blood cells. Tenderness can be developed at the point of impaction, the point of greatest tenderness being in the loin below the level of the kidney or in the iliac region (Perkins). In stone in the ureter pain is not developed by pressure in the loin at the level of the kidney. If a stone partly obstructs the ureter, the urine is pale, of low specific gravity, and free from albumin. Impaction near the bladder causes symptoms similar to stone in the bladder (Jordan Lloyd). These symptoms are frequent micturition, pain, pain in the head of the penis, and bloody urine. If a stone is impacted in the lower end of the ureter a finger in the vagina or rectum will find tenderness and perhaps will feel the stone. In a woman, a stone lodged in front of the broad ligament may be felt by a finger in the vagina. Back of this region and up to the pelvic brim a stone may be felt by a finger in the rectum. A cystoscopic examination, in unusual cases, may show a portion of stone projecting from a ureter (Kelly). Impaction near

the kidney is accompanied by hematuria a radiating into the groin, thigh, or testicle, and symptoms are identical in character with the the renal pelvis. Complete obstruction of the Pyonephrosis results from infection of a hyd stone acts as a ball-valve, plugs the ureter for mass develops, and then allows the urine to faccompanied by disappearance of the lumbar pression may follow blocking of a ureter by a tipped with wax is introduced, a calculus will (Kelly). The x-rays are very valuable in dia

Treatment.-During a painful paroxys packs. The attack may terminate and not ret If such an attack does pass away, the urine act of micturition to see if the stone is voided or two, if the stone does not appear, use the the ureter, and thus discover if the stone is in If the stone is in the bladder, use the Bigelov removal. The stone must never be allowed to and cause subsequent trouble. If a stone is i ureteral orifice and inject sterile olive oil the procedure facilitates the passage of a stone. ureter may be followed by expulsion of the st dures the stone remains impacted in the ur presents itself. An impacted stone is certain the danger it is often impossible to say. In s impacted for many years without obvious ha is rapidly destroyed. The stone may pass long time, and drinking freely of water favors had long had a retained stone, came to the ho the stone. Sooner or later a retained stone v to be removed by operation. It will cause, if i of the ureter, dilatation of the ureter above it, stone increases gradually in size and other extraperitoneal operation is to be chosen in me is impacted below the pelvic brim, it is usually operation, stripping the peritoneum and res (See Ureterolithotomy.)

Abscess of the kidney is caused by tr ture of the urethra, by disease of the bladde scesses, or by pyemia.

The symptoms are pus in the urine (the hematuria in traumatic cases, and pain runr in most cases is alkaline. Constitutional symptomer being far higher than that generally met bladder should be examined with a cystoscopurine flows from the ureter and to identify the possible, to catheterize the ureters.

The treatment in the early stage is rest,

an ice-bag to the loin, followed in forty-eight hours by hot fomentations. When the diagnosis is clear, incise the loin, open and stitch the kidney to the abdominal wall, or, if the organ be badly damaged, remove it.

Pyelitis and pyelonephritis, which usually affect only one gland, are caused by urethral stricture, by stopping of the ureter by blood-clot, by vesical paralysis, by stone in the bladder or in the kidney, and by enlargement

of the prostate gland.

Symptoms.—A patient who has, or who has had, retention of urine develops high fever, often preceded by a chill, and headache, stupor, and dry tongue are noted. Unlike acute Bright's disease, there is neither edema nor dry skin, convulsions do not occur, and the urine is plentiful and contains pus and but rarely blood. The prognosis is very bad.

The treatment is to remove the obstruction if possible. If the urine be acid, give liquor potassii citratis; if alkaline, give benzoic acid. Gallic acid, eucalyptol, and small doses of copaiba or cubebs are recommended. Venice turpentine, camphor, and opium may be given in pill form. Quinin is used to stimulate the patient. The bladder is to be washed out every day with boric-acid solution (gr. iij to 5j of water). Cups, dry or moist, and hot sand-bags or bran-bags are to be applied to the loin. Alcohol may be sparingly administered. Urotropin is a useful drug.

Perinephritis is an inflammation of the perinephric fatty tissue produced by cold, febrile disease, slight traumatism, or the spread of inflamma-

tion from another part.

The symptoms of this condition are rigidity of the spine, the inclination being toward the affected side, flexion of the thigh, pain in the loin and iliac region, and often pain in the knee. The symptoms resemble those of hip-joint disease in the second stage. Suppuration may or may not take place.

The treatment is wet cups to the loin, ice-bags to the loin, rest, purgation by salines, morphin for pain, and, after the acute stage, potassium iodid

internally and ichthyol locally.

Perinephric Abscesses.—An abscess in the perinephric fat is known as a perinephric or perirenal abscess. Primary abscess is caused by chills, acute febrile disturbances, or by pus flowing from some other part, as the spine. Slight traumatisms, by producing hemorrhage, make the perinephric region a point of least resistance and lead to abscess. The causative injury may be produced by digging, stamping, coughing, falling, carrying a burden, lifting a weight, riding on a horse or on a jolting wagon. Consecutive abscess is secondary to kidney inflammation, suppuration, calculus, tuberculosis, or cyst. In the consecutive form the symptoms may be masked by the malady to which perinephric abscess is secondary. As a rule, in perinephric abscess there are found the constitutional symptoms of suppuration. The local symptoms are a deep aching and paroxysmal pain in the loin, intensified by lumbar pressure. There may be pain in the iliac region and pain in the knee. Edema of the corresponding foot and lameness are not unusual. The thigh is often drawn up. The spine is rigid and inclined toward the diseased side. Edema of the skin is usual, but fluctuation is not. The exploratory incision will settle a doubtful diagnosis.

The treatment is to lay open the abscess, wash it out, and drain.

Stricture of the Ureter.—This is use tion of the ureter. It is due to gonococcic infition, or tuberculosis. The symptoms, as Hothose of a vesical or renal inflammation. I ureteral catheter. We may be unable to in it with difficulty and find that the pelvis of the urine obtained is slightly acid or even alkali urine from the other kidney, and perhaps of ureter causes hydronephrosis or pyonephrosis.

Treatment.—Dilatation with bougies, res and anastomosis, resection of the diseased po sound end into the bladder, or division of the s culosis the diseased kidney and ureter may be

Hydronephrosis is a condition of the k iment to the outflow of urine by obstruction the urethra, the calyces of the kidney becon and the glandular tissue being absorbed by p by Albarran that secretion of urine ceases in a distention being due purely to congestion. genital, due usually to twisting of the ureter or the ureter at its point of junction with the being produced because the ureter passes int natural angle. Occasionally imperforate me of both kidneys. The causes of the acquired growths or pregnancy, inflammation or tumo bladder, kidney, or ureter, twisting or kinkin kidney, enlargement of the prostate gland, Acquired hydronephrosis may involve both only a part of a single gland.

Symptoms.—Hydronephrosis is most frequestream bar tumor is absent, there may be no symptom back and abdomen, frequent micturition, a pertion in urine, or even occasional anuria. A twhich growth is dull on percussion and may conoccasionally occurring when it disappears. Hybrid if only one kidney be involved, but deglands suffer. Death occurs from uremia, from or from rupture into the peritoneal cavity. The use of the cystoscope and by catheterizing the

Treatment by aspiration may cure, but t done repeatedly. Tapping on the left side is intercostal space; on the right side the tap last rib and the crest of the ilium. Some few c terizing the ureter (Pawlik). The proper ope rotomy, stitching the edges of the cut kidney ney has been opened, explore the ureter by m elastic bougie. A healthy ureter will permit of the size of from No. 9 to No. 12 of the I opening of the ureter into the pelvis cannot

open the ureter. A valve should be slit longitudinally and sutured vertically (Fenger). If a permanent suppurating fistula ensues or if the organ is found extensively damaged, nephrectomy is to be performed, provided the other

kidney is in reasonably good condition.

Pyonephrosis or surgical kidney is a condition in which the pelvis and the calyces of the kidney are distended with pus or with pus and urine. The whole kidney may be destroyed. This condition has the same causes as has hydronephrosis, for it is in reality usually an infected hydronephrosis. In some cases the inaugural malady is pyelitis, which causes blocking of a ureter. Watson, of Boston, has reported two cases associated with obliteration of the ureter by a mass of fibrous tissue (stricture of the ureter).

Symptoms.—At first the symptoms are those due to the obstructing cause, plus pyelitis. Pus may appear in the urine in incomplete obstruction, or it may intermittently come and go. Constitutional symptoms of suppuration are soon manifest. A tumor may appear in the loin, like the tumor of hydronephrosis. If only one kidney is involved, and if the disease is due to blocking of a ureter, recovery is to be expected. The diagnosis is rendered more certain by the use of the cystoscope and by catheterizing the ureters.

The treatment in the early stages comprises removal, if possible, of the cause of obstruction, and the employment of measures directed to the cure of the pyelitis. If obstruction is not complete, palliative measures may be employed for the tumor. If fever is continued; if there is great visceral derangement; if pain is severe and constant; and if the tumor continually grows, perform a nephrotomy, stitching the organ to the surface if possible, or removing it if it is hopelessly disorganized and the other kidney is in a good or a

fairly good condition.

Chronic Tuberculosis of the Kidney.—This condition may begin in one kidney, no other area of infection existing in the body. In such cases the bacteria were deposited from the blood. Even when the bacteria are deposited from the blood there is, in most cases, a causal focus of tuberculosis somewhere in the body. The other kidney is usually involved subsequently, the process in the first kidney affecting the bladder and secondarily the other kidney. The important point is that tuberculosis of the kidney arising in this manner is at first a unilateral disease.

Tuberculosis of the kidney is seldom a primary disease and usually arises secondarily to tuberculosis of the prostate, bladder, or epididymis. In such a condition the kidney disease is bilateral. Renal tuberculosis is particularly common in the third and fourth decades of life, and is more fre-

quent in males than in females.

Symptoms.—Renal tuberculosis of arterial origin may exhibit no symptoms until the disease is far advanced. Renal tuberculosis secondary to disease of the bladder or prostate always presents symptoms.\* A very common symptom of renal tuberculosis is the sudden onset of polyuria and frequent micturition. The patient is annoyed day and night, and in some cases micturition is distinctly painful. Paroxysms of renal pain are not unusual. The urine is acid, and may contain pus or blood. Tubercle bacilli may be found in the urine or in the sediment, but they may be absent. Repeated examination should be made before it can be stated certainly that bacilli are

<sup>\*</sup> F. Tilden Brown, New York Med. Jour., April 10, 1897.

absent. The presence of bacilli proves the dia not negative it (Willy Meyer). If bacilli are urinary sediment into a guinea-pig, and note animal. Czerny has shown that in cases of bacilli are not found in the urine, the administ great numbers to appear. This agent will also tion if tuberculosis exists. The urine may or n

In many cases the kidney is obviously enlar quently tender and occasionally painful. The procurrent fever followed by sweating. The use important information. It shows from which Catheterization of the ureters should be practistomed to employ it. Always examine carefull kidneys are involved, if the bladder is diseas or seminal vesicles are tuberculous.

Treatment.—Lumbar nephrectomy is not ning of a case, because such a patient may be medical and hygienic treatment, and the weaked nephrectomy may cause the other kidney to Tell such a patient to lead an outdoor life. In the Adirondacks during the summer, and set the winter. If a patient cannot go to anothen necessity of being much out-of-doors. Insist nutritious food. Courses of creasote or guaiaco

If the kidney is markedly enlarged; if ther fever is high and persistent; if only one kidney and prostate are free from disease, perform involvement of the other kidney or of the ger nephrectomy is not justifiable, although nephro benefit the patient for a time.

Operations on the Kidney and Uret Nephritis.- In 1897 Mr. Reginald Harrison kidney to relieve tension in cases of albumin incision of the true capsule of the kidney and pr plish the same purpose ("Brit. Med. Jour., Hugh Ferguson, in March, 1899, reported two cured symptomatically by decapsulation and Amer. Med. Assoc.," March 11, 1899). Dr. between 1892 and 1897, that in certain cases minuria the albumin and casts disappeared aft and Ferguson have observed the same fact. puncture removes the symptoms by abating ter that nephropexy relieves the condition and po vascular adhesions which carry an additional si to operate for Bright's disease in 1800 ("M Edebohls deliberately operated for chronic ne recoveries from chronic Bright's disease ("Me There can be no doubt whatever that operati polyuria, disappearance of edema and other s

at in some cases the disappearance of symptoms has been too rapid to rmit of the assumption that new vessels have caused it. In such cases seems much more probable that relief of tension is the real curative factor. he capsule of the kidney is only slightly elastic, and tension may be brought out by an increase in the blood-supply, by edema, and by cell proliferation. creased tension causes pain and perhaps hematuria, and tension is relieved 'Harrison's plan of incising the capsule. Simple incision is easier, safer, and st as useful as stripping the capsule off of the kidney. Edebohls advocates capsulation and says that the polyuria begins about the tenth day after teration; that improvement begins in one month and is gradual; that the re is due to vascular adhesions; that the adhesions contain more arteries an veins; that the free blood-supply absorbs exudate and products of flammation, frees the tubes and glomeruli from pressure and constriction, uses the reëstablishment of a normal circulation and the regeneration of ithelium ("Med. Record," Dec. 21, 1901).

The exact status of the operation is not as yet determined. It does, swever, seem to be proved that operation is in some cases followed by parent cure or great amelioration of the condition. Whether permanent re is ever thus obtained is doubtful, and the part played by rest in bed ad drugs in effecting an improvement must not be lost sight of. Cases ith pain and bloody urine are often much improved by incising the capsule. Ost-operative suppression and the anuria of acute infectious diseases may favorably influenced by the operation. An important fact which Rovsing aintains and Edebohls proves is that chronic nephritis may be for some time unilateral disease. (Read the views of Schmidt in "Med. Record," Sept. 1902; of Rovsing, of Copenhagen, in "Mittheilungen aus den Grenzgeeten der Medicin und Chirurgie," vol. x, 1902, and editorial in "Jour.

mer. Med. Assoc.," Jan. 11, 1902.)

The operation as practised by Edebohls may be done on both kidneys one sitting or in two séances. In some cases only one kidney is subcted to operation. Edebohls takes a very radical view and would opete on any case free from incurable complications-if an anesthetic can given and if the life-expectancy without operation is not less than one onth ("Med. Record," Dec. 21, 1901). Ether is given or nitrous oxid nd oxygen. Lay the patient prone with an air-cushion under the belly. ad expose the kidney by a vertical incision at the edge of the erector spinæ ass, which cut does not open the sheath of the muscle. Remove the fatty ipsule from the true capsule, continuing the dissection around each pole ntil the pelvis of the kidney is reached. The kidney is extruded from the ound, the true capsule is incised along the convex border and around each ole, is separated from the kidney, and is cut away close to its junction with ne kidney pelvis. The kidney is then returned to its bed of fat, and the ound is closed. (See "Med. Record," Dec. 21, 1901.) Edebohls does ot drain unless there is considerable edema. Edebohls reports 18 operaons without a death. In 9 of the cases the operation was done more than ne year ago, and 8 of them are said to be cured. Personally I do not believe nat the operation can really cure Bright's disease. It cannot restore altered onnective tissue and epithelial cells. The new blood-supply must be through car tissue, and we have yet to learn that such a blood-supply can be good.

The operation should be restricted to acute r in chronic cases, to conditions with severe re albumin percentage, or persistent and notab urine voided (Ertzbischoff, in "Archiv. génér

Nephrotomy.-Nephrotomy means incisi sometimes, though wrongly, applied to the ex without incision. When the kidney wound is is, the operation should be called nephrostor to evacuate infectious material, relieve tension culus or exploration of the ureter, and for dia struments required are scalpels, a blunt-poin toothed forceps, a grooved director, hemost tractors, a fountain syringe, an Allis dissector, needle-holder. If looking for a stone, have a forceps and a scoop to remove the stone, and away adherent calculi. The patient lies upo or a cylindric air-bag being placed under th inch below the last rib and close to the mass, and runs obliquely downward and for 3 inches, the incision being enlarged later if superficial fascia, the fat, the external oblic internal oblique, and the outer edge of the exposes the lumbar fascia. Push aside the lumbar fascia, when the perirenal fat will bulg layers of fat exist. Tear this fat through wi Allis dissector to expose the kidney, which can into the wound by the hand of an assistant r

Kocher's incision for nephrotomy is be sacrolumbalis muscle and the twelfth rib, and and outward to the axillary line (Fig. 229). subcutaneous tissues, lumbar fascia, the la

posticus inferior muscles.

Edebohls' method enables the surgeon to oughly because this organ is brought outside prone, with a large cylindrical inflated rubbe vertical incision is made close to the borde from just below the last rib to just above the muscle is not opened. The fibers of the la blunt dissection. The iliohypogastric nerve transversalis fascia is incised and the fatty ca of the fatty capsule are torn through and t capsule is well separated from the kidney fr pulled by the legs toward the foot of the tabl This change of position brings the pad bene ration takes place, the kidney is forced into th drawn and thoroughly examined. A commo is to make a longitudinal incision through it to admit the finger into the renal pelvis. T necessary until the kidney is split in half.

close the kidney wound completely with a round needle and catgut, unless drainage is necessary or packing is required. Another incision is placed longitudinally a little posterior to the convex border. This goes through the bloodless zone of Hytl, and causes less hemorrhage than the incision along the convexity. Marwedel's incision is a transverse cut at the middle of the convex border of the kidney into the renal pelvis. It is doubtful if this incision is accompanied by less bleeding than longitudinal incision of the convexity. After the completion of our work on the kidney the lumbar wound is closed

completely or is partially closed to permit of drainage.

Operation for Stone in the Kidney.—(By Pyelotomy or Nephrotomy).— It used to be held that incision of the pelvis of the kidney is far more apt to be followed by fistula than incision of the substance of the kidney. The Mayos, Bevan, and others have proved that this conviction is untrue. In many cases pyelotomy is preferred to nephrolithotomy. It is used for single stones of moderate size in the pelvis and unaccompanied by suppuration. When we have a large branched stone, coral-shaped stones, multiple stones, and stones accompanied by distinct and gross evidences of infection, then nephrotomy should be preferred to pyelotomy (Beyan and Smith, in paper read before the American Surg. Assoc. in 1908). In both operations the patient is placed on the sound side with a sand-pillow or cylindric air-bag under the flank. In both cases the incision recommended for nephrotomy is used. In both cases the kidney is lifted into the wound or brought out of the wound so that it may be satisfactorily palpated. In both cases bleeding is controlled by having an assistant grasp the pedicle with his fingers or with a pair of forceps, each blade of which is covered with a bit of rubber tube, while the surgeon opens the pelvis or the kidney tissue, removes the stone, and explores with the finger.

Pyelotomy.—Remove the fat from the posterior surface of the pelvis of the kidney. We may then be sure that no aberrant vessel is in our way. The normal vessels are all in front of the pelvis. The posterior wall of the pelvis is now opened, the stone is extracted, the pelvis explored, the cut in the pelvis sutured with fine catgut sutures, the kidney is restored to place, a cigarette

drain is introduced, and the wound in the loin is closed.

Nephrolithotomy.- The methods of incision, exposure, and opening the kidney are described on page 1200, under Nephrotomy. When the kidney has been opened, loosen the calculus with the nail, and remove it with the finger, with a scoop, or with forceps. After removing the stone, suture the incision with catgut, and release the pressure on the pedicle. Hemorrhage will rarely occur. If in spite of this plan bleeding occurs, take out the stitches and apply pressure and hot water, or in some cases plug with iodoform gauze for twenty-four hours. When hemorrhage ceases, put a large drainage-tube down to the kidney. Close the wound in the muscles and integument and dress antiseptically. The dressings must be changed frequently and the tube should be shortened daily. In some cases nephrectomy is necessary (page 1291). Formerly in these cases I always drained for a time and removed the kidney secondarily, believing that the patient would gain strength in the interval and stand the severe operation of nephrectomy better. I am satisfied that in most cases this view is wrong, because removal of a kidney bound down by adhesions is one of the most perilous and difficult operations of surgery.

Nephrectomy.-Nephrectomy is the removal of a kidney. There are two

methods of nephrectomy-the lumbar and th tomy was performed, according to Watson, ir The operation was transperitoneal and was kidney. Simon, in 1869, performed the firs first successful nephrectomy. Before per the competence of the kidneys. If at least excreted, it is very unsafe to operate. Be kidneys. Examination of the bladder by c orifices, a strong indication that both kidr when we reflect that a horseshoe kidney has two Catheterization of the ureters is advisable if probably require a specialist to perform it. of two kidneys consists in feeling both of then and if uncertain as to the competence of th each kidney during the operation and befor preliminary exploratory laparotomy.

Lumbar Nephrectomy.—The instrumen scalpels, a blunt-pointed bistoury, forceps as a clamp, retractors, spatulæ, blunt hooks, needle, a grooved director, stout silk, an A a Paquelin cautery. The patient is placed is placed under the loin. Several incisions cases the oblique incision is first made to cision is begun half an inch below the last ri spinæ muscle, and is carried downward and In some cases a kidney can be removed th the cut must be enlarged. It can be enlarged ward. Morris enlarges it by adding to it a one inch below the origin of the oblique cut. tomy consists of a vertical cut by the edge of to the iliac crest, from which point it is curve and is carried to or even through the rect posure lift the kidney and separate it fro with the finger; clamp the pedicle; pass an the vessels of the pedicle; ligate in two pl and arrest hemorrhage permanently by ligat be healthy, ligate it with silk and drop it be scrape it with a sharp spoon, wash it with corr pure carbolic acid, and then either ligate it ar wound. If hemorrhage persists from the wo drainage-tube and close the wound. If the pe close it with Lembert sutures. Kocher's me surgeon to feel the opposite kidney before re to be diseased. The incision is begun as carried forward so as to expose the reflecti colon in the posterior axillary line (Fig. 229). is opened, and the surgeon's hand is inserted feels the other kidney. If another kidney exi

\* Kocher's Text-book of Ope

the diseased organ may be removed. Brewer's personal statistics show 53 cases of nephrectomy with 2 deaths, a mortality of 3.8 per cent. ("Med. Record," March, 20, 1909).

Abdominal nephrectomy is more dangerous than the lumbar operation. The same instruments are required as are used in the preceding operation. The position is supine. The incision is that of Langenbeck-four inches long in the linea semilunaris, its center corresponding to the umbilicus. Open the abdomen, introduce a hand, feel the kidneys, and if both show serious disease, do not perform nephrectomy. If we decide to remove one kidney, keep the small intestine away by pads, push the colon toward the umbilicus, incise the outer layer of the mesocolon, and bare the kidney. Strip off the peritoneum from the kidney and its vessels, and ligate the vessels by passing strong silk through the center of the pedicle with an aneurysm-needle. Ligate the ureter if healthy, and divide it. If the ureter is septic, fasten it to an opening made in the loin by cutting onto forceps pushed to the outer edge of the quadratus lumborum. Stop bleeding, irrigate the belly-cavity, and dress as usual, employing drainage only when septic matter has passed into the peritoneal cavity or when oozing of blood is persistent.

Nephrectomy in Children.—The operation is proper in certain non-malignant troubles. Jepson did a successful nephrectomy for a congenital cystic kidney on a patient four months and fourteen days of age. Rovsing did it successfully for congenital hydronephrosis, the patient being nine months old. Roswell Park did a successful nephrectomy for congenital cystic kidney on a child twenty-three months of age. The value of nephrectomy for sarcoma is more than doubtful. The operation never really cures, and if an operative recovery is obtained, the disease appears after a time in the other kidney. Jessup performed nephrectomy in eleven children and every case died within two and one-half years of the operation. The operation often prolongs life and relieves discomfort, but does not cure.

Partial Nephrectomy.—This operation may be performed in some cases for wounds, cysts, and innocent tumors. After removing the damaged or diseased part, bleeding points are ligated with catgut. The wound-surfaces are approximated as well as possible by catgut sutures. Drainage is introduced. The value of partial nephrectomy in some cases seems certain, and we should apply it when possible instead of the complete operation,\* except in cases of malignant disease.

Renipuncture.—This is an operation devised by Reginald Harrison for the relief of albuminuria due to elevated tension. The kidney is exposed in the loin, the capsule is incised, and punctures are made in the kidney. Simple incision of the capsule will usually relieve nephralgia. (See Operations for Chronic Nephritis.)

**Nephropexy** is fixation of a movable kidney. The term nephrorrhaphy, so long used for the operation, really means suturing a wound in the kidney.

The Author's Modification of the Elder Senn's Operation.—Many surgeons feel that it is not desirable to pass sutures through the kidney-substance, and I have entirely abandoned the use of them in operations

<sup>\*</sup>See Oscar Bloch in Brit. Med. Jour., Oct. 17, 1896; also reports of Czerny, Bardenbeuer, Tuffier, and Kümmell.

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for movable kidney. Urinary fistula has fol value of such sutures is very doubtful. The and if it is suspended by sutures, they are certai operations the kidney when restored to place is n has its ureter and vessels looking forward; in oth twist in the ureter. In operations like Goelet's kidney much nearer its proper level and which do vessels, the upper pole is not anchored and tend Senn's operation fixes the kidney without using s

The patient lies upon his abdomen, Edebohls' neath the lower abdomen. A vertical or slight made, the perirenal fat is exposed, and its two lakidney is reached. The fatty capsule is thorou



Fig. 769.—Gauze slings, each composed of two pieces sutur

organ. The kidney is brought out of the wour pulling the patient toward the foot of the bed, s ribs, when traction on the fibro-fatty capsule wi from the wound. The posterior fatty capsule is c fatty capsule up to the hilum. The true capsule if necessity exists, the organ is decapsulated. Is by suturing together with the finest plain catgut t form gauze. Two such strands are prepared (Fig gauze is placed under the upper end of the kidney lower end, the sling in each instance being direct suture line external and not in front as the kidney the back (Fig. 770). When the kidney is replaced front (Fig. 771). The kidney is replaced and will two pieces of gauze, the ends of which protrude fro

is placed below the lower renal pole to fill up the space which always exists there and to stimulate granulation. This space below the kidney is a frequent cause of subsequent loosening in most suture operations, because the kidney hangs in it unsupported, as a bucket hangs in a well. Harris recognizes this, and in his operation closes the space by sutures. Gauze is packed in over and about the kidney, and over this the two long slings are tied. Several sutures are inserted to close the lumbar aponeurosis; some are tied and some are left untied. A large gauze pad is placed upon the abdomen over the anterior surface of the kidney, and the lumbar wound is dressed with gauze. The dressing and gauze pad are held in place by a binder. In about eight or ten days the gauze should be soaked with salt solution during half an hour and the packing removed. At this

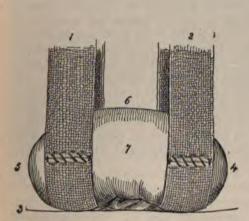


Fig. 770.—Right kidney projecting from wound. Observer standing on right side of patient: 1 and 2, Slings in place, with sutures external; 3, skin of the back; 4, upper renal pole; 5, lower renal pole; 6, convex border of kidney; 7, external surface of kidney. (Slings should be broader than is shown in cut.)

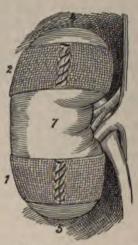


Fig. 771.—Right kidney restored to place, seen from in front: I and 2, Slings in place, sutures anterior; 4, upper renal pole; 5, lower renal pole; 7, anterior surface of kidney. (Slings should be broader than is shown in cut.)

time the catgut is destroyed and the gauze can be easily pulled out. The tied sutures are cut and removed, the sutures left unfastened are tied, and a small piece of gauze is inserted as a drain between the granulating surfaces. If a continuous piece of gauze was used, ether must be given before removal is attempted. Further, in the old operation, a large wound was left to granulate and weeks were often required to obtain healing. In this operation the wound is usually entirely healed in from eighteen to twenty-one days. After the performance of nephropexy the patient remains in bed for three weeks. By this operation the kidney is placed in a proper situation, is surrounded with granulations, which are converted into scar-tissue, and the organ becomes encased in a box of fibrous tissue. I believe that a kidney so treated will probably remain fixed.

Ureterolithotomy.—If the stone is impacted in the upper two-thirds or three-fourths of the tube it may be reached by an incision from the twelfth rib downward and forward to just anterior to the anterosuperior spine of

the ilium and then parallel to Poupart's ligament until above its middle The peritoneum is stripped up as in extraperitoneal ligation of the iliac vessels The ureter adheres to the peritoneum. The operation is strictly extraperitoneal. The tube is opened by a longitudinal incision. The stone is removed. The ureter is explored by means of a sound to see if it is free and may then be sutured with catgut, but will heal perfectly well without stitches. The tissues above the ureter are sutured and a bit of rubber tissue is carried to the duct. Gauze packing must not be carried down into the ureter, as it would make a urinary fistula. Whenever possible-and usually it is possible-reach the ureter by the extraperitoneal route, and even well below the brim of the pelvis the peritoneum can be stripped and the ureter opened from behind. If the stone cannot be reached by the extraperitoneal method, open the peritoneal cavity and incise the ureter. After removing the stone, suture the wound in the ureter with inversion-sutures, fasten an omental graft over the suture-line (Fenger), and drain. In a woman a stone near the vesical opening can be reached by a vaginal incision. Stone in the vesical portion of the ureter may be removed after the performance of a suprapubic cystotomy or by an operating cystoscope.

My colleague, Dr. John H. Gibbon, advocates a combined intra- and extraperitoneal route for stones anywhere in the lower two-thirds of the ureter. The peritoneal incision permits of exploration and exact localization of the stone, allows the surgeon to push the calculus from an inaccessible into an easily reachable position, and makes the removal vastly easier. The stone is removed by extraperitoneal incision of the ureter, and the peritoneum is closed (John H. Gibbon, in "Annals of Surg., Gynecology, and Obstetrics," May, 1908).

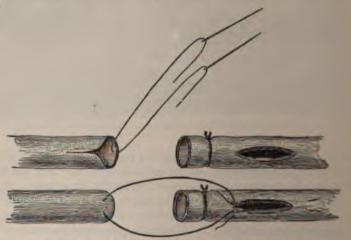


Fig. 772-Van Hook's method of ureteral anastomosis.

Uretero-ureterostomy (Van Hook's Operation).—In this operation lighthe lower end of the divided ureter with silk or catgut. About one-four of an inch below the ligature make an incision in the long axis of the tube. This incision is in length equal to twice the diameter of the tube. Each end of a piece of fine catgut is threaded to a fine needle. This thread is passed through the upper end of the ureter (Fig. 772). The needles are

made to enter the lower end of the tube through the door made by the surgeon. They are pushed through the wall of the ureter one-half an inch below the door (Fig. 772). Traction upon the strings causes invagination, and the ligature-ends are tied. If the operation is intraperitoneal, the ureter is wrapped about with peritoneum.

Intestinal Implantation of the Ureters.—This operation may be employed in exstrophy of the bladder and in vesical cancer, in which it is necessary to remove the bladder. After this operation there is danger of infection of the ureters and consequent ascending ureteritis and pyelonephritis, and the presence of urine in the bowel usually causes inflammation of the rectum and incontinence of urine may take place.

Maydl asserts that a piece of the bas fond should be removed with the ureter, and implanted with it into the intestine, the flange hanging free in the lumen of the gut. If this is done, the relations of the ureter to the muscular coat of the bladder are not interfered with, stricture is less likely to occur, ascending infection is antagonized, and suppurative conditions arise at the margin of the flange, rather than, as in other methods, directly in the cut ureter. Maydl has collected the records of fourteen cases operated upon by this method, with two deaths.\* In vesical exstrophy Peterson transplants a vesical flap containing both ureteral orifices into the descending colon.

**Cystoscopy.**—Cystoscopy is the employment of the cystoscope for the study of the interior of the bladder, the prostate, the ureteral orifices, and the appearance of the fluid coming from each kidney.

The cystoscope is an instrument of great value in the hands of an experienced man, but is practically useless when employed by a novice. In using a cystoscope the mucous membrane may be burned with the lamp. This causes inflammation, and if an eschar forms, it will be cast off, exposing a granulating surface. Schmidt calls attention to this injury, speaks of the condition as ulcer cystoscopicum, says it is in the fundus, has the shape of the instrument, and heals in from fourteen to twenty-one days ("Jour. Amer. Med. Assoc.," July 19, 1902).

Cystoscopic examination of the bladder owes its present position to Messrs. Max Nitze and Joseph Leiter, who were the first to introduce a practical instrument. The great obstacle in former years was the danger of burning the mucous membrane by overheating of the lamp. The invention of the cold lamp eliminated that danger, and was a great step forward. Nitze was the first to recognize the futility of examination by reflected light and constructed an instrument with the light on the end which to-day is copied by all of the modern instruments.

Cystoscopes may be divided into several types: (1) The examining instrument; (2) the instrument carrying ureteral catheters or the catheterizing cystoscope; (3) the operating cystoscope. They all have certain mechanical features in common, but differ in their construction and lens arrangement.

The examining instruments are of two fundamental types—the direct and the indirect. In the direct there is a straight telescope with a series of wide angle lens that give the picture of the bladder in front and slightly to the side. In the indirect the lens is so ground and set as to enable the operator to look backward toward the prostate.

<sup>\*</sup> Editorial in Jour. Amer. Med. Assoc., May 6, 1899.

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Catheterizing cystoscopes are also of two and the indirect. In the direct catheterizing t from the carrying tubes to the ureters. In the



Fig. 773.-Marks' air-dilating endoscope for exar

directed by a lever on the end of the instrum on the penile end. By raising or lowering the altered to facilitate its introduction into the ur



Fig. 774.—Marks' air-dilating endoscope for exar

It is obvious that the bladder should be a cystoscopic examination. For this purpose, The modern tendency is in favor of water dis instruments, notably that of Prof. Lewis, use a Water as a dilating medium is superior to air, unless operative work is to be done through the instrument, in which case the inevitable hemorrhage precludes the use of water. The air instruments show but a small field and the distention causes pain and often a mild cystitis.

From the foregoing it is plain that one type of instrument is not suited to all cases, and each has its claim to practical utility. Some cases can be most readily catheterized by the direct, while others are only reached by the indirect, plan. It has been our experience that if the ureteral orifices are normally placed, the direct method is quicker and more readily learned by the beginner. Where from any cause the ureteral orifice turns backward (which only happens in a very small percentage of cases) the indirect cystoscope is indispensable, it being practically impossible to reach the ureteral orifice by the direct instrument.

There are at present many different forms of cystoscopes on the market, notably among them are the Nitze, Casper, Tilden Brown, Cabot's modi-

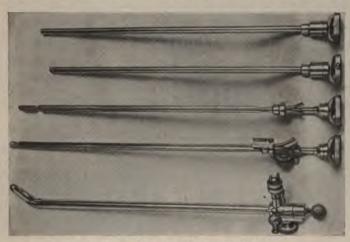


Fig. 775.—Universal cystoscope, after E. Tilden Brown.

fication of the Tilden Brown, Berger, Albarran, Bransford Lewis, and the so-called Universal. In the selection of an instrument best suited to the needs of the general surgeon, the Universal, shown in Fig. 775, will answer in most cases. It combines both the direct and indirect systems of catheterization and the retrograde and direct systems of examination. The universal instruments of Bransford Lewis and Tilden Brown possess features of great practical utility.

The lamp is so situated in the vesical end and the fenestra so arranged that they throw light both on the concave and convex sides of the tip. Hence, all systems may be operated through a single tube and changed without removing the light from the bladder. They provide the following: (1) Direct examination and lateral view, depending upon the angle of the lens and the instrument. The lateral view can be had by withdrawing or extending the cystoscope and also swinging it from side to side. (2) Indirect examination of the trigone, prostatic pouch, and prostate. (3) Double direct catheterizing.

(4) Double indirect catheterizing. (5) Retro (6) Provision for continuous irrigation. The necessary provision, for, in many cases, a succe zation can only be accomplished during contin

and pus.

Sterilization of Cystoscopes and Ureteral C the cystoscope before using, place it for five m oxycyanid (1: 1000) or formaldehyd (1: 500). Some operators use a 5 per cent. solution of phe immersed for twenty-four hours, after which i both neutralizes the phenol and lubricates the solution is easily used and is thoroughly satisfa formalin gas be used, always wash the instrume to prevent irritation by the sterilizing medium.

Ureteral catheters can be sterilized by boili open shallow dish in a saturated solution of chlorid. The following precautions must should be wrapped in gauze and the bottom of to touch each other or curl upon themselves the ruin the instrument. They may also be steril cystoscope, care being taken (if formalin was a germicide, especially from the lumen of the care.)

Contraindications to Cystoscopy.—The least 100 cc. of fluid. Examination is either if the prostate is greatly enlarged. Contracte smaller than No. 24 of the French scale are Papillomata, tumors, and foreign bodies of the acute Bright's disease, instrumentation may be following are further contraindications, as suffering G. Spooner, in "Med. Record," July that operative intervention would be useless; acute cystitis; in tuberculosis in which the ocystoscope.

Technic of Cystoscopy.—The patient si sounded for several days previous to the cystolishes a tolerance in the urethra. He should such as that devised by Tilden Brown or Bransf

General anesthesia is rarely necessary provimanipulations. There are, however, some hy necessary to anesthetize. Cocainization of the posterior portion of the canal of a dram of through the Keyes-Ultzmann syringe will of depositor devised by Prof. Lewis will answer. preliminary lavage of the bladder should be performed the cystoscope sheath or by means of bladder is not diseased, it is merely necessary to urine has been withdrawn, the cystoscope she held in place. The thumb of the left hand prefinger presses upward on the under surface of

raises the beak of the instrument from the sensitive trigone, where most of the pain and hemorrhage are produced by vesical tenesmus.

In regard to a selection of the distending medium, the operator may use terile water, normal salt solution, boracic acid solution, or mercury oxycyanid olution (1: 5000). The bladder should be moderately distended and, if posible, from 8 to 10 ounces are left in the viscus. In contracted or hypersensive bladders it is well to elevate the hips and so relieve the pressure on the ensitive vesical neck and trigone.

The temperature of the distending fluid is of great importance, particularly f there is difficulty in finding the ureteral outlet. If this is the case, the temperature of the fluid should be about 60° F. This enables the operator to see a



Fig. 776.—Tilden Brown's cystoscopic table with patient in position for examination.

o-called swirl when the warm jet of urine mixes with the cold water in the bladder. It is sometimes advisable to give methylene-blue before examining or the same reason. The blue stream from the ureter at once identifies it.

After the bladder is filled the telescope containing the catheters is inserted and the light turned on. The instrument is then held in the median line and bushed gently back, well into the bladder, always making pressure to keep the beak from impinging upon the floor. The cystoscope is now slowly withdrawn, careful watch being maintained through the telescope for the interureteral bar. This structure (about which there has been much argument as to whether treally exists) marks the posterior border of the trigone. The examiner has till another guide in the blood-vessels which run in a general way anteroposeriorly. There is quite a distinct line of demarcation between the fish-net loop trangement of the sides and base of the bladder from that described in the rigone. Fig. 777 gives a general idea of the vascular arrangement. When the nterureteral bar or posterior border of the trigone has been located, the instru-

ment is gently and slowly moved laterally, so th until the end of this structure is reached. I moment and a sharp lookout is kept for the j ureteral orifice is thus indicated. Should the fi the lens, or should the solution in the bladder I tinuous irrigation must be kept up through the

The Ureteral Orifices.—As before mentioned located at the termination of the interureteral b of a triangle found by the vesical outlet and the usually about 1 to 1½ centimeters from the m meters from the vesical end of the urethra. slits or tubercles on the surface of the mucous not always the same. Some of the abnormal



Fig. 777.—The interfor of the bladder, showing arran, A, B, interureteral ba

with are as follows: one ureter close to or furl line, both ureters emptying into the bladder clo about one-quarter or one-half the length of the vesical outlet and in some very rare instances b Sacculation and pocketing of the bladder with brane often makes localization difficult. It is of methylene-blue or indigo-carmin may enable locate them.

After locating the ureteral orifice the vesical directly over the entrance and the catheter proje it is allowed to remain for a moment in order sphincter muscular fibers. The patient is instructionary orifice is carefully watched until a jet of urine act the catheter is gently inserted in the orifice, and greatly facilitates the passage of the instrupassed the sphincter muscle it should be carried.

pressure. The practice of passing the instrument quickly, so commonly resorted to by the novice in order to gain time, is pernicious, and almost invariably causes laceration and hemorrhage. Before inserting the catheter some operators prefer to coat it with paraffin in order to render it absolutely smooth and further to assist in the detection of calculus. This is not neces-

sary. Any instrument with an imperfect eye should be discarded.

The round-pointed catheter should be used wherever possible, as with it there is less danger of injuring the delicate mucous surfaces of the canal. The sharp-pointed olivary tipped instrument often causes blood to appear. If possible, insert the catheter into the pelvis, for then hemorrhage from trauma is less likely to invalidate the examination, and spasm of the ureter, with sucking in of the mucous membrane in the eye, is less likely to occur. Having finished the catheterization of one side, the instrument handle is swung to the opposite side and a similar procedure is carried out. Always have a distinguishing mark upon the catheters. A very good method is to use different colored instruments, so that there may be no confusion after withdrawal of the cystoscope. In some cases only one ureter can be catheterized. In these cases the bladder should be thoroughly washed and the other catheter, left on the floor of the bladder, will collect the urine from the uncatheterized side and give a fair idea of the condition of that kidney.

Removal of the Cystoscope.—The light should be turned off and a small amount of fluid allowed to escape through the barrel. The lens system carrying the catheter is then loosened and gently rotated from side to side to free the catheters. During this procedure the catheters are fed gently backward, but not with sufficient force to cause kinking, and the lens system removed. Next the sheath is withdrawn by carrying it straight up over the abdomen.

Collection of the Urine.—The catheters are carefully wiped with sterile gauze and permitted to drain into separate bottles or test-tubes, marked respectively right and left. The orifices of the receivers should be plugged with sterile absorbent cotton, which will collect and prevent any admixture of urine or water coming from the bladder by capillary drainage. The bottles should also be held in such position as to prevent such capillary drainage reaching them. With regard to the collection of the samples, there are certain precautions that should be observed: (1) The samples should, if possible, be collected in three separate bottles from each side, allowing each set to remain in position a definite time, generally one-half hour. These should be carefully watched and marked first, second, and third half-hours. They should each be examined separately, and by a summation of the examinations the opinion should be reached. Almost invariably microscopic blood can be found in the urine drawn by catheterization of the ureters. In a study of 15 cases of normal ureters where blood was not present in the combined urine, after the greatest care in catheterizing, microscopic blood was present in all but 3. The erythrocytes are usually most numerous in the first bottle, gradually diminishing, until in the third there are but very few or none. Should the blood increase in amount in the bottles, it is an important clinical fact.

In some instances one or both catheters fail to drain. This may be due to a bubble of air in the instrument, impinging of the mucous membrane upon the eye, plugging by blood-clot, mucus, pus, or particles of gravel. A syringe is then essential. The blunt needle should be inserted into the catheter and

suction applied; should this fail, not over 4 cc. may be injected through the catheter. This provery gently, because of the danger of overdilating ducing colic.

A uropyknometer is used for taking the spec of urine removed by the ureteral catheter.

The Operative Cystoscope.—The most protect that devised by Prof. Bransford Lewis. This the removal of small portions of stone and for and ureteral orifices. It is also most useful for ated areas. It is not wise to remove papilloma most villous papillomatous growths sooner or malignancy and should have their pedicles remove wall, which can only be safely done after supraporation.

Practical Value of Cystoscopy and Ure cystoscope has attained a very important positi tarium. It undoubtedly affords the best metho diagnosis founded on pathologic findings. By the presence and character of cystitis, stone, forei Without it the presence of ulcerations could men ical history. Its greatest field is in the early diand vesical hemorrhages. In the detection of r to have revolutionized surgery. It makes poss growths before malignancy has signed the paties prostatic hypertrophy, in which the lobes proje rately diagnosticated without the cystoscope; wil the clinical diagnosis positively confirmed. Ita foreign bodies, such as stone, pieces of cotton, urethra, thus saving formidable cutting operatio the great difficulty found by surgeons in former y of symptomless hemorrhage, a problem which solution.

Ureteral catheterization makes possible the pelvis of the kidney in cases of ureteritis and pyo

The technic of lavage is as follows: A glass s capacity is equipped with a blunt needle that About 5 to 10 cc. of the irrigating fluid is instill mitted to run out. In introducing the fluid car renal pelvis be overdilated. Overdilatation caus the following solutions may be used: Saturated erally used as a cleanser before any other fluid followed in suppurative conditions by a solution stronger as the case requires). The injection is the catheter while irrigating. Subsequently, the land the patient given a genito-urinary antiseptic, than urotropin.

A differential diagnosis must sometimes be n ease appendicitis and movable kidney with dila determining the carrying capacity of the pelvis. producing marked symptoms, the renal pelvis is usually dilated. When the trouble is due to the kidney the pain induced by the distention is similar to that from which the patient has suffered. If a stone is present in the ureter the x-ray picture will usually reveal it, but here again there may arise doubt as to the exact course of the canal. Catheters passed into the ureters with a lead wire in them and the case skiagraphed will enable the radiographer to determine their exact course. Fig. 778 demonstrates the practical utility of such manipulation. Phleboliths, fecal masses, concretion, and calcified lymphnodes have been mistaken for ureteral stone. Appendices have been removed when the source of trouble has been impacted stone in the right ureter. An impacted stone in the ureter may often be dislodged by passing a catheter into the ureter and, if possible, beyond the stone. A few minims of sterile olive oil

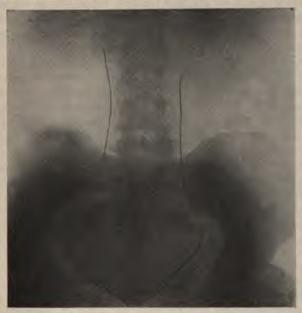


Fig. 778.—X-ray photograph, showing the course of the ureters by wires in the catheters. (Taken by Dr. W. E. Manges.)

are then injected through the catheter, which act as a lubricant and assist in the passage of the stone. Dilatation of the ureteral orifice, by leaving the catheter *in situ* or passing a second instrument alongside of the first, will often cause the stone to pass into the bladder.

Disinfection of Urethral Catheters.—Metallic instruments are cleansed by boiling. Soft-rubber and elastic catheters can be sterilized by mechanical cleansing with soap and water and boiling for five minutes. The common custom of immersing a soft-rubber or elastic catheter for five minutes in a 1: 2000 solution of corrosive sublimate is a useless waste of time, as such a procedure will not sterilize an infected instrument. Of course, a catheter coated with varnish or resin cannot be boiled in water or placed in steam. The best method of sterilization for woven or varnished catheters is formalin vapor. Catheters, after being cleansed mechanically, should be placed in 2

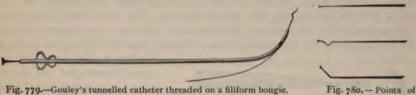
glass cylinder the bottom of which is perfor placed for twenty-four hours in the vapor of for instruments are kept ready for use in a gla chlorid (R. W. Frank, in "Berliner klin. W using, the catheters are washed in sterile water to scrub catheters with soap and water, dry the them in the vapor of sulphurous acid for forty-

DISEASES AND INJURIES OF

Retention of Urine in the Malecourse, a disease: it is rather a result of one or By this term is meant an absolute inability retention may be complete, not a drop emerging a dribbling setting in after a time, due to paral becomes unable to contain more fluid, expu ureters being produced by atmospheric pressur the engorgement, the overflow, or the incontiner retained urine in a man with enlarged prosta being voided. This is not retention, and the sidual urine. Of course, true retention may prostate. Retention may be caused byurethral stricture, hypertrophied prostate, infla impacted calculus, or foreign body, urethral perineal abscess, imperforate prepuce, congeni tumor of the prostate, prostatic abscess, abs abscess, and pressure from a large pelvic tumo cause is spasm of the membranous urethra stricture, acute gonorrhea, or gleet. (2) Dej impairment of the nervous apparatus for ind a rare cause in men. We see retention with fractures or spinal concussion, in certain distimes in shock and peritonitis, often in the characterized by muscular wasting, from the donna, opium, or cantharides), and after cert about the rectum. The last-named form of inhibition of the expulsor muscle or to refle vesicæ, causing it to remain firmly contracte suddenly and is sometimes the first thing that stricture to seek a surgeon.

Symptoms.—In acute retention there is a the patient making acutely painful straining often passed. There are severe pain and a perineum, and penis. All the symptoms rap inaugurated, and death closes the scene unle is from time to time alleviated by the passage are slower in evolution and are less intense, an Some cases of gradual onset, due to atony, feeling no particular pain and complaining of

really the overflow of retention, and is not a sign that the bladder is successfully emptying itself. In any case of retention the bladder rises above the pubes, and there is found a pyriform, elastic, fluctuating mass in the hypogastrium, which mass is dull on percussion and gradually enlarges until the bladder is evacuated or incontinence sets in. The flanks give a clear percussion-note, and the tumor is more prominent when the patient is erect than when he is recumbent. Long continuation of obstructive disease, producing partial retention with or without attacks of complete retention, disorganizes the kidneys. Acute and complete retention may induce rupture of the ure-thra or urinary suppression.



Gouley's whalebone guides (filiform bougies).

Treatment.—Place the patient upon his back, keep him warm, and if

Treatment.—Place the patient upon his back, keep him warm, and if instrumentation does not rapidly succeed, give an anesthetic. Never attempt to use a catheter when the patient is erect. To do so may cause serious or possibly fatal shock. Be sure that every instrument is aseptic. In organic stricture try to pass an elastic, olivary-pointed catheter (Fig. 782, a). Do not use any force until the neck of the catheter engages in the stricture. Then an experienced operator may warily use a certain amount of force, but never much. When the instrument enters the bladder, draw off but half of the urine, withdraw the instrument, wait a few hours, insert it again, and then empty the bladder and wash out the viscus with warm boric-acid solution. To



Fig. 781.-Nélaton's catheter.

draw off all of the urine at once is dangerous, because the sudden relief of the pressure upon distended veins leads to bleeding from the mucous membrane and hemorrhage into the bladder-walls. After the bladder has been emptied the patient is wrapped in blankets, a bag of hot sand or of hot water is placed against the perineum, and a hot-water bag is laid upon the hypogastric region; when he recovers from the effect of the anesthetic he is given suppositories of opium and belladonna, and tablets of salol and boric acid are administered for several days. If it is found impossible to insert a rubber instrument, make an attempt to carry a filiform bougie into the bladder. Fig. 780 shows filiform bougies. If the stricture is

known to be organic from previous history, at On this bougie, after it has been inserted, G be threaded (Fig. 779) and carried into the bithe catheter, we can simply leave the filiform. The filiform bougie will act as a capillary dempty the bladder. Then insert another bout for several days, using also opium, ordering attempt to dilate the stricture forcibly until remation has subsided. If no bougie can be p totomy (suprapubic or perineal). In spasmo metal catheter firmly against the face of the occur and the instrument will eventually pascurve of a metal instrument. An individual which has given but little trouble may developed



Fig. 782.—a. French olivary gum catheter; b. Mercier's elbowed catheter (coudê); c. Mercier's double-elbowed catheter; d. curved gum catheter.

gent, pass a soft catheter. In the occluded with a tenotome. In a congenital cyst of the bougie, which will rupture the cyst. In com puce. In impacted stone try to pull out the if this fails, cut the urethra, or, in rare cas the bladder. In fecal impaction scrape out enlarged prostate try to pass an instrument an ordinary Nélaton catheter (Fig. 781) stren filiform bougie nearly to the beak. If, how enters markedly into the urethra, Mercier's couor his double-elbowed instrument (Fig. 782, c). fail, a metal instrument with a large curve may ous tool and one capable of inflicting grave inju deject use a soft catheter (Fig. 781). Cases of require warmth, confinement to bed, the admini of the skin, and the use of such drugs as salol, b to asepticize the urine. In some few cases no in bladder. In most of such cases aspirate-wh if necessary-and in a day or two, when swe instrument can be passed. A small asepticize pushed into the bladder, the trocar or needle be just above the pubes, and taking a course downward and backward. The parts are first prepared antiseptically, and the puncture is dressed with iodoform and collodion. Only half the urine is withdrawn at a first aspiration. Rectal puncture is now obsolete. The perineal incision is the one usually employed for retention. It may be done with or without a guide. In prostatic retention, not relievable by a catheter, make suprapubic drainage or do prostatectomy.

Congenital Defects of the Bladder.—Exstrophy of the Bladder (Ectopia Vesica).—Exstrophy of the bladder is a condition of defective development commoner in males than in females. The anterior abdominal wall having failed to close, the anterior wall of the bladder being absent, and the arch of the pubes not having developed, epispadias exists, and in many cases the testicles do not descend into the scrotum. In this condition the posterior wall of the bladder projects into or beyond the gap in the abdominal wall; the urine constantly flows and renders the condition of the patient

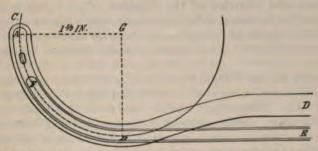


Fig. 783.—A B E shows the proper curve (reduced in size) for unyielding male urethral instruments; CBD shows an improper curve.

dreadful. The condition shortens life and only 30 per cent. of the victims live beyond the twentieth year, death being due to pyelonephritis.

The only treatment which offers hope is operation, and operation often fails. If possible, operate when the patient is about five years of age. Various operations have been suggested for this condition, viz.: covering with skin-flaps; implanting the ureters into the bowel (Maydl, Albert, Roux, Simon, and others); division of the posterior ligaments of the sacro-iliac joints, bringing the arch of the pubes forcibly together, the patient wearing a support



Fig. 784.-English silk-web catheter.

until the parts become firm, when the greatly narrowed defect is closed in by integumentary flaps and suturing the bladder edges (Trendelenburg's operation or synchondroseotomy); osteotomy through one ilium or both ilia instead of separation of the sacro-iliac joints (Berg's operation), or after extirpating the bladder, loosening the ureters from the bladder, drawing them down, and attaching them to the end of the penis (Sonnenberg's operation).

A bladder closed in by autoplasty, by Trendelenburg's operation, or by Berg's operation is never really continent, although when the patient is erect

and wears a light compress he may perhaps be hours. The above methods are suited to young is ureteral transplantation. Tuffier showed, transplantation of the cut ureters into the borby fatal infection of the kidney, and that the cretain the ureteral orifices which contain valve

Maydl introduced his operation in 1892. the ureters into the sigmoid flexure, extirpati have twice performed a modified Maydl's operecovery, and in the latter case the result was ("Surg., Gynecol., and Obstet.," Feb., 1909) collection there were 23 deaths (28.7 per cent.) pyelonephritis. Bergenhem, in 1894, devised the ureters and a portion of bladder through rectum.

Diseases and Injuries of the Bladd situated, and the abdominal walls are so elastic empty. If the bladder be full and the abdom in alcoholic intoxication—force applied upon bladder.

Contusion of the Bladder.—In this conhematuria, tenesmus, severe cystitis, and an inbecause of clots. Hemorrhage may be very even causing death. When contusion exists of a clean soft catheter; if this fails because catheter with blood-clot, there must, from tir the catheter from a fountain-syringe a solut cooled boiled water. Gross's blood-catheter of Bigelow may be employed. The patient is applied to the hypogastrium, morphin is ad the bladder is washed out several times a day integrate and remove blood-clots, and the urine by the stomach administration of salol, boric fluids. Hemorrhage usually ceases on reliev some more radical measure must be employed

Wounds of the Bladder.—Besides being injured by bullets; by stabs or punctures throof or the uterus; or by penetration by a fragmer. The symptoms of such conditions are those of In any intraperitoneal wound at once open the in the bladder-wall, irrigate the peritoneal cameans of a retained catheter, a perineal section In an extraperitoneal wound drain the wound by a retained catheter, a perineal section, or a section of the section of th

Rupture of the bladder occurs in three rupture involving the peritoneal coat; (2) extra tion of the bladder not covered by peritone rupture of the mucous and muscular coats, peritoneal investment. The causes are of two

citing. Predisposing causes are: distention of the bladder; drunkenness; cystitis; ulceration; degeneration or atony of the bladder-coats; prostatic enlargement, and urethral stricture. Distention of the bladder is the great predisposing cause. It causes the bladder to rise from the pelvis and so become exposed to a direct blow, it places the organ under tension, and force tends to rupture the weakest point. In about one-third of the cases collected by Bartels the individual was intoxicated at the time of the accident. Drunkenness predisposes because a drunken man is very liable to injury and is apt to have a distended bladder. Males are much more liable to rupture than females (10 to 1). Most cases are between the ages of twenty and forty. Of Besley's 23 cases, I was a child of three, I a man of forty-nine, 3 were in the first and second decades, 5 were between twenty and thirty, 7 between thirty and forty, 6 between forty and fifty, and in 2 the age is not given (paper before Chicago Surg. Soc., Feb., 1907). The condition is very rare in children, but one of Besley's cases was three years of age, and King recorded the accident in a fetus with imperforate urethra.

Exciting causes are: obstruction to the outflow of urine (by stricture or enlarged prostate); external violence; falls upon the feet or the buttocks, as well as upon the abdomen; lifting; straining at stool, in micturition, or during parturition; and the forcing of injections into the bladder. A distended bladder may be ruptured by a concussion. The most usual cause of the injury is a crush. The mechanism of the injury is in dispute. It is certain that the bladder must have lost its elasticity by distention. When force is applied to fluid (and fluid is incompressible) the bladder tears at its weakest point. The weakest point is not identical in all individuals. It may be weak anywhere from disease. The most common site of the tear is at the posterosuperior aspect, but it may be in front, at the sides, or at the pubic or prostatic ligament (Staubenranch). The mucous membrance or the peritoneum may give way first and the tear may be anteroposterior, oblique, or longitudinal. Alexander maintains that the most usual cause of the injury is a crush which forces the distended bladder against the sacral promontory, but Besley's (Ibid.) experiments do not indicate this to be the case. A common complication, especially of extraperitoneal rupture is fracture of the pelvis, due to the same force that ruptured the bladder.

Symptoms, Diagnosis, and Treatment.—The symptoms are not always definite, and every characteristic one may be for a time absent, the patient seeming in some rare instances of extraperitoneal and intraperitoneal rupture to possess the power of retaining his urine and of voiding it. As a rule, however, there are found some or all of the following symptoms, following an accident or occurring during the progress of a causative disease: severe abdominal pain, collapse; inability to walk or great difficulty in walking; excessive desire to urinate, but inability to do so; a catheter, when used, brings away pure blood or a very little bloody urine; the catheter occasionally slips through the tear into the cavity, and more bloody water comes away. In some reported cases clear water has been withdrawn. If a measured amount of boric acid solution is injected, it is improbable that all of it can be withdrawn by the catheter, although in some cases it may all come away (Alexander, in "Annals of Surgery," Aug., 1901). Injecting fluid fails to lift the bladder into the hypogastric region so as to be recognizable on percussion. Severe hypogastric pain and

rectal tenesmus come on after a temporary shock in vesical rupture is so severe that death there is delirium, often septicemia and peritonitimay occur. In intraperitoneal rupture general but its appearance may be postponed for sever In these cases the extravasation is noted as a one side only. In extraperitoneal rupture the neum, the scrotum, the thighs, and under the in the back, and may soon induce sloughing. In is apt to arise.

In doubtful cases pump air or hydrogen ir a bicycle pump can be used (Brown), or a Day directions are to insert a catheter, empty the bi the catheter a disinfected Davidson's syringe being fastened over the distal end of the syr through the cotton is pumped into the bladde rise above the pubes as a pyriform tumor, ruptured bladder will not so rise. In intrar pass into the general peritoneal cavity and di peritoneal rupture injection will produce en connective tissues. On removing the syringe bladder is unruptured, but little if any comes ander considers gaseous distention unreliable shock and disseminates infection. His rule is in a case of suspected rupture of the bladde and inspect the prevesical space for signs o extraperitoneal rupture is not found, open the l

Treatment.—In extraperitoneal rupture af der insert a drainage-tube. In intraperitonea the Trendelenburg position, expose the bladd opening in the viscus.

Results.—Baron Larrey was the first surgeon all the coats of the bladder might be followed be ruptures if operation is not performed the mort tion is performed many cases recover. Of the and Papin, in 1904, 34 died, a mortality of 43 extraperitoneal rupture without operation the with operation 30 per cent. (see Daniel N. E. Assoc.," Oct. 25, 1902; Samuel Alexander, "And the coats of the coats

Atony of the bladder is a condition in the bladder is diminished or lost because of The bladder is very thin, and the muscles are fatty degeneration. Sometimes the viscus is very small. A slight degree of atony is physic causes are senility, distention from true pa from obstruction, and acute overdistention.

Symptoms.—In atony of the bladder the 1 (a symptom probably existing for some years may even do so while asleep. The stream, w projection, but drops at once from the end of the penis. Residual urine exists for years and may at any time set up cystitis, and retention with incontinence is apt to occur. This condition is *not* vesical paralysis resulting from a lesion of the nervous system.

Treatment.—In treating atony of the bladder measure the residual urine: if it amounts to four ounces, use a soft catheter night and morning; if it amounts to six ounces, use the catheter every eight hours; if it amounts to eight ounces, use the catheter every six hours (J. W. White). The patient should be taught how to use the catheter and how to keep it sterile. (For methods of disinfecting catheters see article on page 1305.) The bladder is from time to time washed out with gr. iij to the ounce of boric-acid solution at a temperature of 100° F. Strychnin, electricity, ergot, and urotropin may be ordered.

Vesical Calculus, or Stone in the Bladder.—The salt normally in solution in the urine may deposit as calculi and may be imprisoned in any portion of the urinary tract. The commonest calculi are those composed of uric acid, urates, calcium oxalate, and fusible phosphates. The formation of uric-acid and urate calculi is explained under Renal Calculus (page 1281). Vesical calculi are usually renal calculi that have passed the ureter and become enlarged by new accretions. Phosphatic calculi may be formed in the bladder when chronic cystitis causes and maintains an alkaline urine. Uric-acid calculi are smooth, round or oval, and hard, but easily broken. On section they present the color of brick-dust and are marked by concentric rings. Their nuclei are dark by comparison. They are soluble in dilute potassium hydrate, and with effervescence in nitric acid. They are combustible, and leave scarcely any ash. Urate of sodium and urate of ammonium often occur together in stones, and these calculi are not in rings, are not so hard as the uric-acid stones, and are fawn-colored on section. Oxalate-of-lime stones are round, with many projecting nodes like the mulberry, hence the term "mulberry calculus." They are very hard, and section shows the color to be brown or green and that they possess wavy, concentric rings. This form of calculus is soluble in hydrochloric acid. Fusible calculus, which is composed of magnesic ammonic phosphate with phosphate of lime, constitutes the commonest form of phosphatic stone and of large stone. It is light, soft, smooth, and white, and shows no laminæ on section. Some rare forms of stone are composed of xanthic oxid, cystic oxid, calcium phosphate or carbonate, and magnesic ammonic phosphate (triple phosphate).

A stone may be formed having layers of different substances; for instance, there is often found a uric-acid nucleus surrounded by phosphates, the latter surrounded by some uric acid or urates, and these again by phosphates. In some cases oxalate of lime alternates with uric acid, urates, or phosphates (Bowlby). Bowlby states that the alternating uric-acid and phosphatic layers are due to the altering reactions of the urine; that when the urine is acid uric acid is deposited on the stone, but when cystitis makes the urine alkaline the stone receives a phosphatic coat.

Anything that favors the formation of an excessive urinary deposit may cause vesical calculus, and among such causes are defective digestion, failure in processes of oxidation, excess of solids and nitrogenous elements in the diet, deficient exercise, etc. If to the urinary condition established by the above

factors catarrh of the genito-urinary tract is a concentrated urine may induce stone. Children stones, and old people to phosphatic stones. prostate and chronic cystitis a stone forms nucleus. The nucleus may be phosphate crys a blood-clot, uric-acid gravel, or a foreign be because of the shortness, the large diameter, as urethra. Stone is very rare in the negro. enlarged prostate, vesical atony, urethral stric tion of the kidney, the ureter, and the bladder

Symptoms.—In not a few cases the vesical attack of nephritic colic. The severity of the sy depends more on the roughness of the stone th calculus will produce intolerable anguish, where will cause but moderate pain. A patient wi plains of frequency of micturition, particularly sudden, uncontrollable, and invoked or aggrav tom is more positive in youth than in old age. acter is experienced at the end of micturition. empty bladder upon the stone or stones. It enters and distends the bladder. The usual se



Fig. 785.-Thompson's calcula

face of the head of the penis, a little behind continue for some time. By pulling on the pe puce of a child may become pendulous. This worse during cystitis and after exercise; it ma it may even almost disappear, and it is always old. Stone in chronic cases of atony and in c neither marked pain nor frequency of micturit pain precedes the act of micturition, in urethral in stone, as already stated, it jollows it. (P. J. Feb., 1898.) The symptoms are somewhat of vesical calculus and prostatic hypertrophy. with calculus are spoken of as attacks of stor may during micturition roll into the urethral interruption of the flow of urine, the stream a changes his position. This symptom is seldor rare in the old, the stone in them dropping in and below the urethral orifice. Even if this s clusive, as a stalked tumor, a blood-clot, or block the urethral orifice and cut off the stre not be noted; it is most usual after exercise, urinary act, the first urine passed being clear \*" American Text-book of

tinged, and at the end of the act some drops of pure blood emerge. It is not one of the earliest symptoms. When it occurs, it puts the patient in a great fright. It does not appear suddenly and profusely, but as gradual and trivial bleeding and with micturition. Blood appearing between acts of micturition comes from either the urethra or prostate (P. J. Freyer). The bleeding from a bladder tumor is profuse and the urine is mixed with blood and blood-clots and tumor fragments. Bleeding from a tuberculous ulcer of the bladder often resembles the bleeding caused by stone. Pus or mucopus will be observed if cystitis occurs with calculus disease. Priapism occurs in some cases. Pain of a reflex nature may be felt in the rectum, in the perineum, or in some distant part.

The above symptoms, even if all are present, do not prove that an individual has a stone in the bladder. To prove the presence of a stone, it must be touched with a sound and the contact must be felt and heard. To sound a patient, have the bladder well filled with boric-acid solution or salt solution, and place him recumbent, with the knees drawn up. Never sound a person while he is standing, because of the danger of syncope. In an ordinary case in a male use a sound with a very slight curve (Fig. 785); in a man with hypertrophied prostate use a sound with a short and decided curve. The caliber of a stone-sound is No. 13 of the French scale. The instrument is carefully boiled and anointed with yellow liquid cosmolin. Examine the entire bladder systematically, and be sure a stone is present only when contact with the sound is both heard and felt. The stone may be difficult to find, or it may elude the instrument entirely when it is encysted, when it rests in a diverticulum, when it is fixed to the roof or anterior wall of the viscus, or when it is crusted with lymph or blood-clot. In doubtful cases always insist on a second examination, giving ether if the first was very painful. Occasionally, as Freyer pointed out in 1884, a small stone will be found by using a Bigelow evacuator, the current causing the calculus to knock against the tube. In many cases stone in the bladder may be detected by means of the x-rays. If a stone is fixed in a diverticulum or projects from the ureter, or is in a sac back of the prostate, it may be missed by sound and evacuator tube but be shown by the x-rays. In such a case the bladder must be examined by means of a cystoscope. A stone, when it is detected, should always be measured by Thompson's instrument, an arrangement looking something like a small edition of a lithotrite, but having very delicate blades. The composition of the stone is assumed from an examination of fragments which pass by the urethra or which adhere to the measure. Remember that the outer layer of a calculus may be soft phosphate and the inner portion may be the harder uric acid, urate, or oxalate.

Stone in Females.—Calculus in the female is a rare complaint. In over poor patients operated upon for stone by Freyer there were only 20 females. Pain and increased frequency of micturition, which are symptoms of stone in men and women, are in women caused by other conditions as well, notably by a terine disease and displacement. A straight sound is used to examine a female for stone. If the surgeon is still uncertain after sounding, he dilates the urchra and explores the bladder with his little finger.

Stone in Children.—Can occur at any age, and congenital cases have been placed or record. The uric-acid stone is most common. The symp-

toms are like those of the adult. The pain ca penis and the prepuce becomes pendulous. I of urine is blocked from time to time, the ch and after a time a hernia may form or prolapse

Treatment.—In people predisposed to s the physician should foresee the danger and on the urine being kept dilute by the freest reduce to a minimum the amount of alcoho taken. Let the patient live chiefly on green eggs, fish, poultry, weak tea or coffee, water, wine. Continued purging does harm by co laxative may be employed when indicated. of immense importance, sunshine and fresh for a condition of imperfect oxidation power. piperazin, gr. xv to gr. xx daily, liquor potas or borocitrate of magnesium. If the urine b mineral acids and strychnin, or, what seems Urotropin is given in gr. v capsules four tin with oxalate, use the mineral acids with an of sodium. Travel and rest at the seaside or in all forms. Always endeavor to prevent when it does occur. When a stone is once fo of dissolving it. An operation must be done. upon the age, the state of the bladder and th urethra, the kidney condition, the size and c number of calculi present (see Operations o

Cystitis.—Inflammation of the bladde of some other disease of the genito-urinary t and wet. Traumatism from a catheter, the of a urethral inflammation, pus infection, and the use of such a drug as cantharides not unusually during an exanthematous fer paralysis; it often follows retention, frequen tate and urethral stricture, and sometimes a or accompanies bladder growths. Acute c swelling of the bladder-walls, and there is pre is mixed with urinary elements, serum, mucus Ulceration, sloughing, or false-membrane f cystitis is an inflammatory condition always speak of a chronic cystitis as due to stone in prostate gland, or tumor of the bladder. chronic cystitis, but act by rendering the bla isms. Among the causative organisms we communis, the gonococcus, the bacillus tub and the various pyogenic bacteria (Leonard gain entrance on instruments or by way of vessels, and possibly in rare instances by the

In chronic cystitis there is an enormous pr and the urine becomes alkaline. The exces great number of bacteria convert the urea into carbonate of ammonium, and this product, being irritant to the bladder-walls, makes the inflammation worse. In chronic cystitis the bladder is contracted and has very thick walls, and the mucous membrane is thick, edematous, congested, and filled with large veins. The bladder may be ulcerated or encrusted with urinary salts. The urine contains bacteria, triple phosphate, pus, blood, and mucus, the blood emerging with the last drops of urine. Pyelitis may arise as a result of chronic cystitis.

Symptoms of Acute Cystitis.—Great frequency of micturition, with the passage, at each act, of a very small quantity of urine; the desire to urinate is almost constant, and there is intensely painful straining (tenesmus). The pain is acute and scalding, and may be felt above the pubes or in the perineum; it often runs into the loins and the thighs and radiates over the sacrum. Pain above the pubes indicates involvement of the fundus, and pain in the perineum and in the head of the penis points to inflammation of the bladderneck. The urine, at first clear, loses its transparency, becomes full of thick mucus, and often contains a little blood or pus. The patient not unusually has some fever. A rectal examination causes violent pain. If ischuria takes place, there will be a chill and high fever, and anuria may occur or vesical rupture may ensue.

Treatment.—In treating acute cystitis endeavor to remove the cause. By allaying an irritation or removing an obstruction the bladder will often become able to empty itself of retained urine, which urine causes congestion of the bladder and thus renders infection probable or may be itself filled with bacteria. If cystitis arises from the administration of cantharides, put the patient in bed and give him liquor potassii citratis. If it comes from the use of a clean sound, order rest in bed, suppositories of opium and belladonna, diluent drinks, and ammonii benzoas or lupulin. If the inflammation is septic (as from the use of a dirty sound) or is very acute, put the patient in bed, keep him warm, and use a hot sand-bag to the perineum and hot fomentations or poultices to the hypogastrium. Hot hip-baths may be used. The hips should be elevated and the bowels should be emptied by the administration of salines and by glycerin enemata. An exclusive milk-diet is desirable. The patient should drink copiously of sweetened water containing a few drops of aromatic sulphuric acid or of milk of almonds. Sterilize the urine by the administration of urotropin, giving a capsule containing gr. 71 of the drug three times a day. Other remedies which may be of service in sterilizing the urine are quinin, boric acid, salol, borocitrate of magnesium, and salicylate of sodium. A valuable remedy consists of 15 grains of salicylate of sodium and 15 grains of benzoic acid, given three times a day in a little chloroform water. If the pain and straining still continue, order-

R.	Ext. hyoscyami, Ext. cannabis indicæ,	gr. viii;
	Sacchar. alba,in puly. No. xxiv.	gr. xlviij.—M.
	One powder every four hours.	

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R.	Camphoræ,
-	Ext. cannabis indicæ,
	Sacchar. alba,
Div	in pulv. No. xx.
Sig.	-One powder every three hours.

Suppositories of extract of belladonna are of g containing gr. j of ichthyol are of service, and hours. If these remedies fail, the surgeon which, unfortunately, constipates; when it is g use of glycerin suppositories, by the administ by the employment of enemata. If opium is pository containing gr. j of powdered opium ladonna every three or four hours. Hypod may be required. Wash the bladder out dail tion or warm boric-acid solution. This can be or, better, by hydrostatic pressure. If retentiff much blood is passed, give internally the tirthe perineum. A very acute cystitis is rarely days.

Symptoms of Chronic Cystitis.—This concute cystitis or it may appear without any There will be found frequency of micturition, form. There will be slight tenesmus and mo radiating toward the head of the penis. Consider when kidney-damage has become pronounce absorption. The urine is ammoniacal, fetidiviscid, tenacious mucus or with mucopus; it could be phates, and occasionally clots of blood. The with the production of immense quantities of the chronic catarrh of the bladder." Chronic formation of stone or in the production of the ureters, and the kidneys. It often occasional countries and the kidneys.

Chronic Tuberculous Cystitis.—Chronic c losis. Primary tuberculosis is very uncommo culosis are secondary to renal tuberculosis tate, seminal vesicles, or epididymis. Some tubercle bacilli being found in the urine. In cilli are found. The tuberculous products car organization takes place. A cystitis for which which is accompanied by pyuria and severe tuberculous. Pyuria is usually present, but fectly clear. In some cases the patient has duration and feels well between the attack the kidney, prostate, vesicle, or epididymis, tuberculous cystitis exists. The diagnosis is berculous ulceration is most common in the tri of the urethra. A tuberculous ulcer is small brane is not inflamed, but contains gravish-w in "Jour. Amer. Med. Assoc.," July 19, 190

Treatment.—In treating chronic cystitis remove the cause, if possible (get rid of a stone, evacuate residual urine frequently, dilate a stricture, and remove a tumor). For chronic cystitis certain remedies are taken by the mouth. Water is drunk in large amounts, also iron spring-water (Marienbad, etc.). Salol and boric acid, gr. v of each four times a day, are very valuable. Salol in fluid extract of triticum repens does good; so does chlorate of potassium, gr. x daily. Either borocitrate of magnesium, quinin, or salicylate of sodium with benzoic acid may often be used with benefit. Alum, tannic acid, uva ursi, copaiba, cubebs, buchu, and turpentine have all been recommended, and possibly may be of some benefit. Urotropin is useful in many cases. This drug prevents the development of bacteria in the urine (Nicolaier) and antagonizes the tendency to sepsis and urinary poisoning. It is given in 5-grain capsules, from four to six being given daily. Whatever remedy is used, see that the bowels move once a day, and that the skin is active. Champagne and beer must be avoided. If residual urine gathers, a soft catheter must be regularly employed. If it is possible to introduce a catheter of considerable size, catheterization may be all that is needed in the case. In some cases of chronic cystitis the retention of a catheter from three to five weeks is of the greatest service. If the case is very severe, the bladder must be washed out daily with peroxid of hydrogen (25 to 40 per cent. solution), nitrate of silver (1:8000), boric acid (5 to 10 per cent.), carbolic acid (1:500), corrosive sublimate (from 1:20,000 to 1:5000), or permanganate of potassium (1:4000). If nitrate of silver or permanganate of potassium is used, first rinse out the bladder with distilled water. If any other agent is used, first wash out the bladder with either boiled or distilled water. The daily injection of a 2 per cent. solution of ichthyol may prove useful. Some surgeons occasionally employ, at intervals of a number of days, strong silver solutions (30 or 40 grains to the ounce). If a strong solution is used, after the drug flows away wash out the bladder with a solution of common salt. The bladder is usually washed out by attaching to the free end of a soft catheter, the other end of which is in the bladder, a tube which is connected with a graduated bottle, the force being obtained by elevating the reservoir (fountain irrigation). The bladder can be irrigated without using a catheter, the resistance of the compressor muscle of the urethra being overcome by the pressure of a column of water. The reservoir is raised to the height of six feet. The patient sits in a chair. The tube of the reservoir has upon it a clamp to control the flow, and in its end a large bulbous tip which will fill the meatus (Valentine's instrument). The tip is inserted into the urethra, the clamp on the tube is loosened, and the patient its directed to take a deep inspiration. In a short time the bladder fills with water, the tube is removed, and the patient empties the viscus naturally. In some cases it is necessary to wait quite a while for the column of water to tire out the muscle. If the fluid will not enter, direct the patient to make efforts, as in micturating, the pressure of the fluid on the anterior surface of the cut off muscles being kept up. If this fails, direct him to urinate, and then the surgeon makes another attempt to get the fluid to enter. After a little practice a patient learns how to admit the fluid.

In tuberculous cystitis Collin advises the instillation of 30 minims of the following mixture into the bladder and posterior urethra: 5 gm. of guaiacol, 1 gm. of iodoform, 100 gm. of sterile olive oil. About 30 minims of this are

injected once a day. If the cystoscope discletuberculous, it is useless to operate on the ulcoformed on the kidney. Sometimes cureting ten other cases the bladder must be opened, con nary non-tuberculous cystitis Collin uses a recarbonate in oil.

If the ordinary methods of treatment fail bladder resents catheterization and irrigation urine does not become clear; and if there are patient and breaking down of his general heal pubic cystotomy and through the incision wa thoroughly. If the persistent cystitis is due to to cure, perform external perineal urethrotomy

Ulcer of the Bladder.—May be due to malignant tumor, or gonorrhea. A form of u in anemic women is a solitary, punched-out u. Amer. Med. Assoc.," July 19, 1902). Ulcer Perforation may occur.

A perforation may occur into the peritoner cellular tissue. In the former case, after the there are shock, abdominal pain, and peritoni extravasation of urine or abscess-formation.

Tuberculous ulcer is discussed on page 131 Schmidt ("Jour. Amer. Med. Assoc.," J gonorrheal ulceration is apt to be multiple, and turbid urine. As a rule, when the bladder is blood, blood-clots, or tissue débris, but the urin tuberculous ulcer or solitary ulcer (Schmidt, i

Diagnosis is usually made by the cystosc

by exploratory suprapubic incision.

Treatment.—If there is one ulcer, or if there an operating cystoscope (Schmidt), use irrigation in wide-spread ulceration perform suprapublic mucous membrane, and insert a drainage-tube growth the cautery is used as a palliative mean as is rupture of the bladder (page 1310).

Tumors of the Bladder.—These grow rare, but in Guyon's statistics they are found to cases of genito-urinary disease. They are a males as in females. They are most frequent of fifty and sixty, although myxoma is met with its most common in the young (Lincoln Davis, 1906). Persistent vesical irritation may, perhatumor. Tumors of the bladder may be either in being the commonest. Innocent tumors which are papillomata or villous tumors, adenomata fibrous polypi, myomata, and angiomata.

lioma, common). The majority of bladder carcinomata are secondary to growths of the rectum, prostate, or uterus. Adenocarcinoma and scirrhous carcinoma are practically always secondary to rectal, prostatic, or uterine tumors. Papillary cancer and epithelioma are not unusually primary (Mandlebaum, in "Surg., Gynecol., and Obstet.," 1907). Any tumor of the bladder, innocent or malignant, will eventually cause death if allowed to remain.

Symptoms.—The innocent tumors rarely cause cystitis or irritation, hough by obstructing the ureters or the urethra they may induce disease of he kidneys. Hematuria is almost invariably present at some time in the course of a bladder tumor. It is apt to be profuse, and the urine contains blood, blood-clots, and perhaps fragments of tumor. The bleeding is intermitent, may occur even when the patient is at rest, and, except in malignant disease, is seldom preceded or accompanied by pain. Bleeding usually occurs at he termination of micturition, the first urine being clear and the last red or clotted. Often hemorrhage is the only phenomenon produced by a papilloma or a mucous polypus. Malignant tumors cause cystitis, and the urine contains nucus, blood, and pus. The growth may become crusted with salts from the arine. Cancer is distinctly and often horribly painful. In malignant disease alceration may occur into the peritoneal cavity or gut. A malignant tumor progresses much more rapidly than an innocent growth, although in cancer netastases are not formed so early as in some other regions. Innocent tumors are felt with difficulty with the sound, but malignant tumors are easily felt. In some cases a tumor can be detected by a bimanual examination (a finger in the rectum and the fingers of the other hand on the abdomen). Make a careful study to determine whether or not a growth has nfiltrated the prostate, the seminal vesicles, the rectum, or the perivesical issues. Bleeding follows the use of a sound. There may be difficulty in starting the stream in micturition, or there may be interruption or "stammering" of the stream. The urine should be examined microscopically to see f it contains villi, portions of fibroma, colonies of cancer-cells, or fragments of epithelioma. A cystoscope should be employed in order to reach a diagnosis. If the urethra is too narrow for the cystoscope, this channel must be dilated. If there is profuse bleeding, an irrigating cystoscope must be emoloyed. In doubtful cases exploratory suprapubic cystotomy is advisable.

Treatment.—Complete extirpation of the bladder for cancer has been performed by Bardenheuer and others. It is usually done in two stages, in the first operation the ureters of a man being transplanted into the rectum, he ureters of a woman into the rectum or vagina. About three weeks later the bladder is removed. The adjacent lymph-nodes along the internal iliac ressels and in front of the sacrum must be removed in all cases. The surgeon should bear in mind that scirrhus and adenocarcinoma are secondary growths, and if he cannot remove the primary growth he should not extirpate the bladder. The complete procedure has been carried out successfully at one operation Tuffier and Dujarier, "Rev. de Chir.," April, 1898). Some surgeons prefer preliminary double lumbar nephrostomy; others transplant the ureters to the skin surface. The operation of complete extirpation is of questionable

alue.

In Rafin's collection of 30 cases there we five years after operation, 1 fifteen months, son's table of 25 cases shows 14 deaths and and free from recurrence after three years.

Complete extirpation should be employed bladder extensively. I agree with Berg ("A if less than one-third of the bladder is involved cystectomy with implantation of the ureters it ing. The surgeon removes the anatomically mind that adenocarcinoma and scirrhus are Partial cystectomy saves the fatal operation is ordinarily done, or the dangerous operation of its unpleasant consequences. In Rafin's 21 deaths (a mortality one-half that of completed—5 were well over three years and 16

Many surgeons content themselves in vesi omy, removing the growth and a portion is not possible, curet, cauterize, and drain. and a portion of the bladder-wall are removincision. The perineal operation only enamove growths of small size, pedunculated grof the bladder. (See Operations on the Blathe following rule: "When an infiltrating vaginam, or with the sound, to be involving wall, to be infiltrating its coats, especially ters and neck of the bladder, no operation unless the hemorrhage is copious or the sthen an incision for palliative purposes "System of Surgery").

Operations on the Bladder.-Lat the removal of a stone from the bladder. which is every year becoming less popul employed by surgeons, especially for stor should not be performed if the stone is over it is rarely justifiable if the stone weighs th it must not be performed for encysted stone. neum, a narrow pelvic outlet, or an enlarged the operation keep the patient in bed, wash boric-acid solution, and administer salol and of each four times a day. The night before a hot bath, and have the perineum, the scro sides of the thighs cleansed and dressed an enema is to be given. At the time of ope tain several ounces of boric-acid solution are a lithotomy knife, a straight probe-poir stone-sound, stone-forceps and scoops, a to a fountain syringe, curved needles and a nee tube with chemise (Fig. 200), a Paquelin a lithotrite.

Place the patient upon his back, anesthetize him, and find the stone by sounding. If the stone is not discovered by the sound, do not operate. Place the buttocks so that they project beyond the edge of the table, introduce the staff into the bladder, flex the legs and thighs, and fasten the patient in the ithotomy position with a crutch. During the first incision the handle of the staff is held toward the belly; after the first cut the staff is set perpendicularly and is hooked up under the pubes. An incision is made, starting just to the eft of the raphé of the perineum and one and a quarter inches in front of the edge of the anus, and passing downward and outward to between the anus and the ischial tuberosity, but one-third nearer the former than the latter. In he adult this incision is three inches long. The first incision is superficial and does not reach the staff, but it is this incision which may cut the rectum. After making the first cut the nail of the left index-finger feels for the groove of the staff, the staff is hooked up, the knife is entered into the groove and is bushed into the bladder, and as it is withdrawn the wound is enlarged. As he knife enters the bladder there is a gush of fluid. The finger follows the cnife and stretches the wound, the staff is withdrawn, and the stone is felt for and extracted with forceps. Liston showed years ago the value of keeping he finger in the wound. This maneuver retains some water in the bladder, and as a consequence causes the stone to rest at the lowest part of the viscus. and when the forceps are introduced they at once come upon the stone. In vithdrawing the stone make traction in the axis of the pelvis, and do not rotate he calculus until it is entirely out of the prostatic urethra. Wash or scrape way débris or incrustation from the wall of the bladder, see that no other tone is present, syringe out the viscus with warm salt solution, insert a tube, apply antiseptic dressings around the tube, and put on a T-bandage. The end of the tube which is external to the dressings is fastened to the tails of the I-bandage. A rubber cloth is put on the bed, under the body and legs, and he patient's buttocks rest upon a mass of old linen, the scrotum being raised on a pad. The knees are bent over pillows. Change the linen as soon as t becomes wet. Remove the tube in forty-eight hours. The urine begins o come by the urethra from the eighth to the twelfth day. In children the ncision is not so long, it is dilated with forceps instead of with the finger, nd no tube is required. In lateral lithotomy the prostatic and membranous portions of the urethra are opened, the prostate gland is partly divided with he knife, and the wound is dilated with the finger. One objection to the peration is that it is possible to cut the rectum, and another is that inflamnation may occlude the ejaculatory ducts.

Suprapubic Lithotomy.—This operation is the removal of a stone brough an opening above the pubes. It is in many instances the preferable peration. The mortality of this operation is higher in children than that of ateral lithotomy; in adults and in individuals beyond middle life the morality is decidedly less than is that following the lateral operation. It is used or the removal of multiple calculi, for very hard stones, for stones above one and a half inches in diameter, for calculi in men with enlargement of the prostate, for foreign bodies incrusted with sediment, when the perineum is deep, when the pelvic outlet is narrow, for encysted stones, for calculi associated with a vesical tumor, and when the urethra will not permit the use of a

lithotrite. The patient is prepared as for la pubes are shaved, and the lower part of the the thighs are disinfected. During the oper a piece of antiseptic gauze. The instrument pointed bistoury, scissors, a tenaculum, b retractors, dissecting forceps, a dry dissect rectal bag, a brass syringe or a bicycle pump catheters, stone-forceps and scoops, a blad needle-holder, and a graduated glass jar for

In performing the operation place the pa tion. It is necessary to distend the bladder prevesical space uncovered by peritoneum. bag and push it above the sphincters. Draw wash out the bladder with warm boric-acid 3j of water), and inject the bladder with the the age of five inject three to four ounces; ounces. Withdraw the catheter and tie a ti the escape of fluid. After injecting the blade well lifted, inject the rectal bag with water a In a child inject from two to four ounces of in an adult inject ten ounces. Bristow sugge bladder. Some surgeons simply inject air by syringe or a Davidson syringe. If air is in and the patient is placed on his back rather t burg. The best method of injecting air is th of a bicycle pump.. A catheter is introduced catheter is fastened to a bandage, the bicyc tion is proceeded with, and when the trai bladder is filled with air, the soft catheter opened.\* Make a three-inch longitudinal i hypogastric region, terminating over the sy connective tissue is reached, cut it. If the it up. Hold the wound-edges apart with seen, giving the bladder a blue color. Avoid if they should be cut bleeding will usually c and the rectal bag is removed. Clamp ble transversely with a tenaculum at the upper viscus in the middle line above, and cut town the bladder with hemostatic forceps, and rem bladder, remove the stone or stones, scrape ing vessels outside the bladder, and irrigate tion. Introduce a tube into the bladder, and tube to siphon off the urine. The bladder car Keen's siphonage apparatus (Fig. 786). Sut upper part of the wound. Dress with dry an the dressings and binder being split to go an which siphons over in a bottle containing sor

\* F. Tilden Brown, "Annals of St

dressings as often as they become wet. Take out the tube in four or five days, and allow the wound to heal by granulation. The patient may get up in two weeks. Many Continental surgeons advocate immediate suture of the bladder after incision. Albert, Vincent, Bassini, DeVlaccos, and others advocate immediate suture. The suture material should be catgut. After suture a catheter is kept in the bladder to drain the viscus. Immediate suture may be employed in patients of any age, but should not be used if the urine is very septic or if pyelonephritis exists. In some cases the attempted clesure will fail; in others it will only partially succeed; in many it will prove successful; but even if it only partially succeeds it will tend to



Fig. 786.—Cathcart drainage. The Y-tube is of glass and is darkened in order to be shown against a white background.

prevent dissemination of urine in the prevesical cellular tissue. The chief causes of death after suprapubic lithotomy are septicemia, secondary hemorrhage, cellulitis, peritonitis, and suppression of urine. J. W. White estimates the relative mortality of suprapubic and lateral lithotomy as follows: In children the suprapubic operation gives a mortality of 12 per cent., the perineal of 3 per cent. In adults the suprapubic gives a mortality of 12 per cent., the perineal from 8 to 12 per cent. In old men the suprapubic gives a mortality of 25 to 30 per cent., the perineal 30 to 40 per cent.

Crushing of Vesical Calculi.—This is now done in one sitting, the old operation of Civiale, which required repeated crushings, being obsolete.

Litholapaxy (Bigelow's operation, or rapid lithotrity) is the operation for removing a stone from the bladder in one sitting by thoroughly crushing

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the stone and completely washing away the wonderfully successful if done by an expert. often to learn how to perform it with great It is the best operation in most cases, if perform the operation in the majority of cases for ever but the general surgeon will have better result suprapubic lithotomy than after litholapaxy. method is suited to twenty-nine cases out of employed if the bladder will hold at least four healthy condition; if the urethra is tolerant a if the stone is not too hard, does not weigh over and is not over two inches in diameter. It is for large and hard calculi, for encysted stones



Fig. 787.-Bigelow's latest ev

enlargement of the prostate gland, with vesic easily dilatable stricture need not prevent ti The stricture can first be dilated, and later I formed, but firm, gristly strictures demand a thra is intolerant of instrumentation, the p attacks when it is attempted, cut instead of c ing under kidney disease will do better af cutting (Cage). In diabetes, locomotor ataxis patients are best treated by Bigelow's operatio

The Indian surgeons have had the most lapaxy. It has often been claimed that such i liarities of the patients and various factors re The fact, however, that some of these very surg I repeated their successes in London, shows how large a part masterly terity played in obtaining success.

J. A. Cunningham \* reports upon 10,073 Indian cases of litholapaxy. e mortality was 3.56 per cent.

Cabot, of Boston, in 116 cases had but four deaths, and

two of these were due to pneumonia.

The preparation of the bladder is the same as for lithotomy. Be sure to measure the stone, and to ascertain also whether a lithotrite can readily be introduced and



788. -Bigelow's

lithotrite.

lithotrite.

I instruments in case the surgeon is forced to cut. The patient is esthetized and is placed upon his back, a pillow is inserted under the vis, and he is well wrapped up. The urine is drawn and a measured ount of warm boric acid is allowed to flow into the bladder. This \* Brit. Med. Jour., Aug. 7, 1887.

plan is better than having the patient retain his urine, as in the latter case there is no certainty as to the amount of fluid in the viscus. It is well to introduce at least five or six ounces of fluid, if possible. If the bladder will not hold four ounces the operation is unsafe (Thompson). The lithotrite, preferably the instrument of Forbes (Fig. 790), is now introduced, the handle being gradually raised to a vertical position as the penis is drawn up on the shaft, but not being depressed until the instrument has passed by its own weight into the prostatic urethra. Thompson's plan for catching the stone is as follows: After introducing the lithotrite, let its lower end rest for a few seconds on the bottom of the bladder, so that currents will subside; then draw back



Fig. 791. - Thompson's evacuator.

the male blade, wait a moment, close the blades, and in almost every instance the stone will be caught. If the stone is caught, press firmly to see that the calculus is well held, lock the instrument, and break the foreign body by screwing When resistance suddenly ceases the stone has either slipped or has been crushed; if crushed, the blades should have been felt forcing through the stone and the calculus should have been heard to break. When resistance ceases catch and crush again as above directed. Rapid movements with the lithotrite are inproper, as they establish currents which are apt to push away the stone. If the above maneuver does not catch the stone, see if the calculus be near the neck of the bladder. Pull the instrument close to the vesical neck, and open it, not by pulling the male blade, but by pushing the female blade. If the operator still fails to catch the stone, or if, after crushing, a large fragment knocks against the evacuator,

which fragment cannot pass, conduct a careful search: turn the blades to the right side, open, and close; then to the left side, open, and close; next turn the point around behind the prostate and open, and close. After making a side search with the lithotrite, turn the instrument very slowly, so as to detect the catching of the bladder-wall if it has occurred, and crush the stone in the middle of the bladder with the blades up. After crushing several times proceed to evacuate. Fill the aspirator with warm saline fluid. Insert an evacuating catheter, its point being in the center of the bladder, let the fluid and fragments run out, and attach the aspirator to the catheter turn the valve, and compress and relax the bulb so that an ounce of fluid is forced in at each squeeze, the compression coinciding with expiration. The débris falls into a bulb, and the pumping is continued until the fragments cease to pass, whereupon the point of the catheter is pushed against the floor of the bladder and another trial is made. If fragments which cannot gain exit are felt knocking against the tube, withdraw the evacuator, crush

again, and again use the aspirator. When no more débris comes away and no more fragments are felt, withdraw the tube and carefully sound the bladder. Keyes advises the operator to seek for a final fragment by listening with a stethoscope while pumping at the bulb and searching the bladder with the tube. This operation will rarely occupy over forty minutes, though Bigelow has protracted it for three hours, the patient recovering. A serious complication is severe bleeding, due to damage done with the instrument or to the presence of a tumor which easily bleeds. The injection of moderately hot water or of adrenalin solution (r:10,000) usually checks hemorrhage, but if bleeding is dangerous in amount the operation of litholapaxy should be abandoned and suprapubic lithotomy be performed.

If clogging of the lithotrite with fragments occurs, forcible pushing of the blades together repeatedly will probably amend it; but it will never happen if the surgeon uses a proper form of instrument. A lithotrite with a fenestrated blade will not lock. Forbes's lithotrite is a very powerful instrument, the blades of which will not lock. If the blades of a lithotrite should become forcibly and hopelessly locked, make a perineal section, clear out the blades, close them, and then withdraw the instrument.

Ajter-treatment.—Put the patient to bed, apply a bag of hot water to the hypogastrium, and give him a hypodermatic injection of morphin as he recovers from ether. Give a hot hip-bath every night, and administer liquor potassii citratis in moderate doses every day. If urethral fever occurs, use quinin and morphin, wash out the bladder several times daily with warm boric-acid solution, and tie in a rubber catheter. If retention occurs, use the catheter. If cystitis appears, treat as in an ordinary case. The urine ceases to be bloody in two or three days, and the patient may get up in a week.

Litholapaxy in Male Children.—It was considered until quite recently that a child, because of the small size of the bladder, the small diameter of the urethra, and the readiness with which the mucous membrane is lacerated by even slight violence, was a bad subject for crushing. Lateral lithotomy is known to be eminently successful when performed upon children. The elder Gross did this operation upon 72 children with only 2 deaths. Keegan, however, has persuaded the profession that rapid lithotrity is perfectly applicable to children: He shows that the bladder of a child of even less than two years of age is quite large enough to allow the surgeon to manipulate an instrument; that the mucous membrane is in no danger if the operator be careful, and that the urethra is by no means so small as was supposed. The urinary meatus must often be incised, and after doing this, Keegan states, there can be passed in a boy of from three to six years a No. 7 or 8 lithotrite (English), and in a boy of from eight to ten years a No. 10 or even a No. 14. It is, however, just to state that the operation is more delicate than a like procedure on older persons, and that no one is justified in doing it who has not had considerable experience in adult cases. Furthermore, it should be noted that Keegan's mortality by this operation has been 4.3 per cent., while Gross's mortality from latera! lithotomy on children was 2.67 per cent.

Special points of litholapaxy on male children are as follows: use well-fenestrated lithotrites; have a stylet to punch out the fragments blocking the evacuator; and crush the stone to a fine mass. There can usually be employed a No. 8 lithotrite and a No. 8 evacuating-tube (English scale).

Perineal Lithotrity (Keith's Operation).—This operation is employed by some surgeons in dealing with very hard or very large calculi in male adults, or in cases in which it is impossible to introduce a lithotrite into the bladder. Keith's operation consists in opening the urethra from the perineum, passing a lithotrite through the wound, into the urethra and along the urethra into the bladder, and crushing the stone, introducing an evacuator and removing the fragments. In Keith's operation the incision is median, and opens the membranous urethra. In very large stones, Milton thinks the surgeon should open the bladder as in ordinary lateral lithotomy, introduce a lithotrite through the incision, and crush the stone before extracting it, thus avoiding the infliction of injury upon important structures.

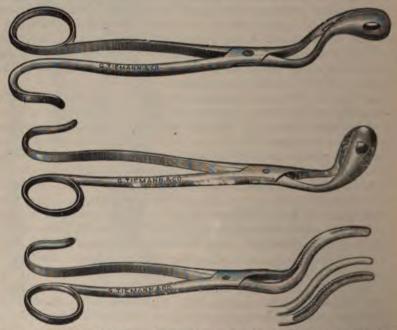


Fig. 792.—Thompson's vesical forceps for removing growths in the bladder; for growths closs in the neck of the bladder, with separation of the blades, to avoid nipping the neck of the bladder.

Operation for Stone in Women.—If the stone be small, give the patient ether, place her in the lithotomy position, dilate the urethra with theuterine dilator until it admits the index-finger, and remove the stone with the finger, the scoop, or the forceps. If the stone is found to be too large to pass, crush it with a lithotrite and get rid of the débris by the evacuator. Large stones (two ounces) may require suprapubic lithotomy. Vaginal lithotomy is never required. If done, it is very likely to leave as a legacy a vesicovaginal fistula. In female children dilate the urethra, crush the stone, and evacuate.

Cystotomy.—This term means the opening of the bladder, and it is usually applied to an opening made for drainage, for diagnosis, for the removal of stones or tumors, or for the treatment of ulcers. This opening may be done by (1) a suprapubic cut (as in suprapubic lithotomy), (2) a lateral

cut (as in lateral lithotomy), or (3) a median perineal cut (as in lithotomy).

operation may be completed in one sitting, or the bladder may be osed, the opening of it being delayed for several days until it becomes to the margins of the wound (Senn's operation). Senn's operation

infiltration of urine into esical space, and it is ado select it if the urine is

nus may persist after pic cystotomy, but usuwound heals unless it is n by some expedient.

effects of suprapubic are very beneficial in thronic cystitis associated



Fig. 793 .- Senn's silver tube.

pertrophy of the prostate gland, the urine being foul. Drainage ne urine to become clear and the mucous membrane of the bladder ne normal. If the opening is made as a permanent drain, there ally be incontinence, as the new channel has no sphincter action lge). Figs. 793, 794, 795, 796, have tubes for prolonged drainage. apubic Cystotomy.—The operation is employed to allow the sur-



-Senn's tube applied. The instrument ess upon the sensitive neck of the blad-

geon to explore the bladder, to treat an ulcer, to provide drainage, or to remove a tumor. If the operation is for calculi, it is known as suprapubic lithotomy (page 1323). After the bladder is opened its interior can be illuminated by the rays of an electric lamp, which appliance is fastened with a mirror to the forehead of the operator. If an ulcer is found, it is scraped with a curet or a spoon. Most cases of tumor require suprapubic cystotomy. It is true that a small single growth at the vesical neck is accessible by median cystotomy, but the area for manipulation is very narrow and the growth cannot be seen. Every large growth, all cases of multiple tumors, and all cases of tumor in individuals with great depth of perineum or with enlarged prostate require suprapubic cystotomy, an operation which allows

el and to see the growth, which gives room for manipulation, and which thorough exploration of the entire bladder. The patient is put in delenburg position if water distention is used, but is placed horizonir distention is employed. After opening the bladder as for stone

(page 1323) hold the edges of the incision apart by means of a speculum (speculum of Keen or Watson) or with retractors, and reflect the electric light into the wound. Growths when seen can be twisted off, a pair of forceps holding the base and another pair being used to twist. Broad growths should be transfixed, ligated, and severed. Some growths (as cancer) are removed piece by piece with Thompson's forceps (Fig. 792), the base of the tumor being scraped. Soft growths are scraped away with a curet, a spoon, or a finger-nail. If bleeding is severe, check it by pressure, by hot water, by a 1:10,000 solution of adrenalin chlorid, or even by the actual cautery. In some cases the wound is allowed to heal rapidly. In others the bladder is drained for a considerable time. In some it is kept open permanently. Permanent drainage is desirable in some cases of enlarged prostate, and in such cases Senn's tube may be employed (Figs. 793 and 794), or Stevenson's tube (Figs. 795 and 796).

Median Cystotomy.—The same incision is made in the perineal raphé in median cystotomy as for median lithotomy. A grooved staff is introduced and is hooked up under the pubes; an incision is made into the membranous urethra, and is extended backward for three-quarters of an inch, and a finger is carried into the bladder. If searching for a growth, find it with the finger, catch it with Thompson's forceps, and twist it off. Soft growths can be scraped away. Stop bleeding by digital pressure or by injections of bot water or adrenalin chlorid (1:10,000). If median cystotomy does not allow access to the tumor, perform suprapubic cystotomy.

Growths in the Female Bladder.—Dilate the urethra as in a case of stone, and scrape, twist, or pull the growth away or ligate it. If the growth is large or if there are multiple growths, perform suprapubic cystotomy.

DISEASES AND INJURIES OF THE URETHRA, PENIS, TESTICLE, PROSTATE, SEMINAL VESICLE, SPERMATIC CORD, AND TUNICA VAGINALIS.

Injuries of the penis and urethra may arise from traumatism to the perineum or the penis, from cuts and twists of the penis, from the popular "breaking" of a chordee, from tying strings around the organ, from forcing rings over it, from the passage of instruments, or from the impaction of calculi.



Fig. 795.—Stevenson's suprapubic drainage-tube.

Violence inflicted upon an erect pens may fracture the corpora cavernosa. The writer saw one man with a glass rod broken off in the canal, he having been in the habit of introducing it at the dictate of morbid sexual excitement. A patient in the Insane Department of the Philadelphia Hospital pushed a ring over his penis, which organ ulcerated into the urethra. These injuries are treated on general principles.

Perineal Bruises.—If the perineum be bruised without rupture of the urethra, the perineum and scrotum swell and become discolored: water is passed with difficulty because the extravasated mass of blood in the perurethral tissues occludes the canal more or less; the water is not bloody; and there are pain and profound shock. Some authors designate as rupture those cases in which laceration of the spongy tissue occurs, without involvement of the mucous membrane or of the fibrous coat, but they are properly contusions.

Treatment.—Place the patient in bed and establish reaction, and when reaction is complete employ opiates for the relief of pain. Apply an ice-bag

to the perineum. If, notwithstanding these measures, swelling continues, introduce a silver catheter (No. 12 English), tie it in, and make pressure upon the perineum by a firmly applied T-bandage or by a crutch braced against the foot-board of the bed. Even when swelling is slight, retention of urine may occur from projection of a submucous blood-clot into the canal of the urethra. In some cases it may become necessary to incise and evacuate the bloodclot. After twenty-four hours have passed, if hemorrhage has ceased, substitute a hotwater bag for the ice-bag, and empty the bladder regularly with a soft catheter. Occasionally, though rarely, an abscess forms. Punctured wounds of the urethra require ordinary dressings. Incised

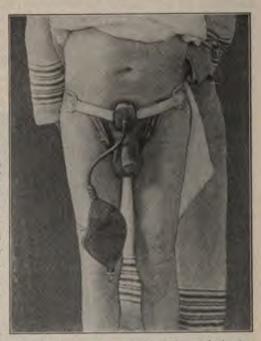


Fig. 796-Stevenson's suprapubic drainage-tube in place and attached to a receptacle for urine.

wounds of the urethra, when longitudinal, are closed by suture. Healing is rapid, and ill consequences are not to be feared. Stricture does not follow. When the wound is transverse, introduce a catheter, suture the wound over the instrument, and remove the catheter at the end of the third day. If a catheter cannot be introduced, employ sutures, but at the first evidence of extravasation open the wound, and if drainage is not free perform external perineal urethrotomy.

Rupture of the Urethra.—By this term is meant a lacerated or a contused wound of the urethra, destroying partially or entirely the integrity of the canal. A lacerated wound may be induced by fracture of the cavernous bodies during erection, the symptoms being severe hemorrhage, intense pain, retention of urine, and inability to pass an instrument; infiltration of urine occurs, and gangrene is a common result. The writer has seen one case of rupture of the penile urethra due to a man's slipping while shaving, the penis being caught in a partially open drawer, the drawer being shut by his body coming against it. Rupture, however, is almost invariably located in the perineum, and it arises when the urethra is suddenly and forcibly pressed against the arch of the pubes by a blow, by a kick, or by falling astride a beam or a

fence-rail. Retention of urine due to stricture may lead to extravasation of urine. The lesion of urethral rupture consists in some cases of laceration of the spongy tissue and the mucous membrane, a cavity being formed which communicates with the canal, and which fills with urine during micturition. In other cases not only the spongy tissue and the urethral mucous membrane are rent asunder, but the fibrous coat is also torn, the canal opening directly into the perineal tissues, among which a huge cavity forms, that fills with blood and later with urine and pus. The urethra may be torn entirely across, but in most cases a small portion at least of its circumference is uninjured. Rupture never occurs primarily and alone in the prostatic urethra; it is extremely rare in the membranous urethra unless due to pelvic fracture; and it is very unusual in the penile urethra. The seat of rupture



Fig. 797 -Ruptured urethra.

in the great majority of cases is in the region of the bulb. Very rarely is the skin broken.

Symptoms.—The symptoms of rupture of the urethra are considerable pain, aggravated by motion, pressure, and attempts to pass water; great shock; in some cases micturition is still possible, blood preceding and also discoloring the stream, for some blood usually runs into the bladder; retention of urine quickly arises; in a vast majority of the cases re-

tention is absolute from the very first, and it is due to the interruption in the integrity of the canal and to the occlusion of the channel by blood-clots. Bleeding, which is usually free, lasts for several hours, some little blood generally appearing externally and much being retained in the perineum, inducing progressive swelling. ence of a large swelling is regarded as evidence of urethral rupture. The blood which is effused in the perineum may extend under the fascia 10 the penis and scrotum (Fig. 797). The swelling soon becomes reddish, purple, or even black, pressure upon it is apt to cause blood to run from the meatus, and it is augmented in volume when attempts are made to urinate After a time, if the surgeon does not act, the urine fills the perineal cavity and widely infiltrates, and there ensue gangrene, sloughing, and sepsis, life being endangered or fistulæ being left as legacies. The course of the extravasated urine will often enable one to locate the seat of injury. In rupture of the membranous urethra, if uncomplicated, the urine remains between the 1800 layers of the triangular ligament until a channel is opened for it by sloughing or by the knife. When extravasation occurs behind the posterior layer of the ligament the urine finds its way to the perineum in the neighborhood of

the anus. When the rupture is in front of the anterior layer of the ligament the urine, directed by the deep layer of the superficial fascia, finds its way into the scrotum and up on the belly, but does not pass into the thighs. A contusion is distinguished from a rupture by the facts that in the former the perineal swelling is not very extensive and does not enlarge on attempting micturition, while in the latter it is extensive and does enlarge on attempting to pass water. Furthermore, contusion does not cause urethral hemorrhage, while rupture does. A contusion sometimes, but not often, prevents the passage of a catheter; a rupture almost always, but not invariably, does so. The mortality from severe rupture with extravasation is about 14 per cent. (Kaufman).

Treatment.—In some cases it is possible to suture the urethra, and this procedure should be carried out when possible. In order to suture, perform suprapubic cystotomy and also make a perineal section. Find the posterior end of the ruptured urethra by passing a catheter from the bladder into the urethra. Suture with silk. The sutures pass through all of the coats of the urethra. The roof of the canal is sutured first, then a steel sound is introduced from the meatus, and the urethra is sutured around the instrument. The sound is withdrawn and the bladder is drained by Cathcart's siphon as illustrated in Fig. 786. In recent cases of ruptured urethra the usual treatment is as follows: Immediately perform median perineal section and turn out the clot; trim off lacerated edges; find the proximal end of the urethra, pass a catheter from the meatus into the bladder, and leave it in situ until healing has begun around it. If the catheter cannot be passed from the meatus, open the bladder above the pubes and find the posterior urethra by retrograde catheterization. In retrograde catheterization we push an instrument from the bladder into the wound and use it to guide a catheter from the meatus into the bladder. When rupture occurs back of a stricture it is a good plan to excise the cicatricial tissue. In cases with extravasation make a median incision and numerous transverse cuts to secure drainage for areas of retained urine or pus. Then, at once perform suprapubic cystotomy. Drain suprapubically and from the perineum for about two weeks, by which time sloughing tissue will have separated. Then find the posterior urethra by retrograde catheterization and do a perineal operation to repair the damaged urethra. (See Eugene Fuller, in "N. Y. Med. Jour.," Nov. 23, 1991.) The wound is packed with iodoform gauze, and the bowels are tied up with opium for a few days. Many surgeons strongly disapprove of the custom of retaining the catheter, believing that the instrument does no real good, as urine is certain to get between the catheter and the walls of the urethra. In fact, it is quite enough to stuff the wound with gauze, the patient urinating through the wound for the first few days, after which time a catheter is used at regular intervals. Whatever method is employed, healing will require from six to eight weeks, and the patient must during the rest of his life, from time to time, introduce large-sized bougies.

Foreign Bodies in the Urethra.—These bodies may be calculi, bodies introduced by injury, as shot, bone, etc., bodies entering from a fistulous opening into the rectum, or bodies introduced from the meatus, as broken bits of catheters, straws, pins, etc.

The symptoms vary with the size and the times there are almost no symptoms; at other pain, retention of urine, and hemorrhage. Ex carefully with a finger in the rectum and by sound, taking care not to push the body back. with water when the body becomes impacted, in close the lips with the fingers, and direct th urination, the surgeon opening the meatus wh tended, the foreign body being often forced out the foreign body is impacted in the pendulous passage by at once tying a rubber tube around body out, and, if unsuccessful, endeavor to cat scoop, or with the long urethral forceps. If upon the body and remove it, dividing any exis just back of the meatus incision of the meatus hairpin is in the canal, the feet of the pin are meatus; to prevent them catching on attempte be squeezed to approximate the feet, and when silver catheter is slipped over to retain them can be extracted. If this fails, drag the peni touch force the sharp ends of the pin out three end off, and then withdraw the other. An ordin out in the same way, and when the head is tur by way of the meatus. If a hard or sharp for prostatic urethra, do not catch it with an instr ward. To do so will be apt to tear the membra push it into the bladder and remove it later by crushing (H. Hartmann, in "La Presse Méd., trite loaded with fragments be caught in the perform a perineal section, to enable him to After the blades have been closed the instrume

Urethrorrhea is not urethral inflammation tiveness of the urethra and oversecretion of the be due to masturbation, sexual excess, and also, drawal during sexual intercourse, and to ungra or two of transparent mucus is found at the n considerable amount may flow away while strain nution of an erection. This flow at stool is of orrhea. This discharge stains but does not discharge contains mucus, mucous corpuscle spermatozoids, but no gonococci or pus orga well in all other respects, but in many cases toms, sexual weakness, or even impotence.

Treatment.—In an uncomplicated case im upon the abandonment of evil habits. If comtreated.

Urethritis, or Inflammation of the U tions can be divided into two classes: (1) simple tion is due alone to pyogenic cocci (particular

nd the staphylococcus pyogenes), and (2) specific, in which the gonococcus is resent.

Non-specific or simple urethritis may be due to several causes, such as aumatism; great acidity of the urine; chancre in the urethra; contact with enstrual fluid, leukorrheal discharge, the discharge from malignant disease f the uterus, ordinary pus, or acrid vaginal discharge; the passage of instruents; the administration of irritant diuretics; strong injections; worms in the ectum; a febrile malady; venereal excess and masturbation; the passage or npaction of foreign bodies, and papillomata of the urethra. A temporary nd mild urethritis sometimes accompanies early syphilitic eruptions. Simple rethritis is less severe and prolonged than gonorrheal urethritis, though inically in the early stage the physician cannot invariably distinguish between ne two forms. The diplococci of gonorrhea are never found in the discharge of mple urethritis, although there may be numerous other diplococci. In edicolegal cases testimony is not admitted as to the presence or absence of iplococci, as judges do not admit that their presence proves or their absence isproves gonorrhea. In the non-specific inflammation pus is not always resent, many cases stopping short of pus-formation after a varying period of starrh, but any catarrh may become purulent. A simple urethritis may be aused or may be prolonged for an indefinite period by the presence of large mounts of oxalate in the urine or the existence of the uric-acid diathesis (see outy Urethritis).

Treatment.—Seek for the cause and remove it. Correct any abnormal ondition of the urine by means of suitable diet, drugs, and mode of life. Iild astringent injections are useful. It may be necessary to flush the urethra

epeatedly with a solution of silver nitrate (1:8000).

Traumatic Urethritis.—The onset pain in traumatic urethritis is coincient with the introduction of the foreign body. The discharge, which may e bloody, mucous, mucopurulent, or purulent, comes on within twenty-four ours.

Treatment.—If the inflammation is slight, prescribe diluent drinks, pareoric, a saline, or the following:

R.	Tinct. belladonnæf5ss
	Sodii bromid
	Tinct. opii camphorat
	Syrupus zingibf5ss
	Aquæ destil q. s. ad. f 3vj.—M.
Sig	—A tablespoonful every six hours,

If the inflammation is severe, put the patient to bed, apply hot fomentations the perineum, give diluent drinks, employ suppositories of opium and

elladonna, and watch for fever and other complications.

Gouty Urethritis.—This condition first manifests itself in the posterior rethra, not in the anterior, as does clap. Its symptoms are great vesical ritability; pain on urination; discharge, usually scanty, associated with urice id in the urine or other symptoms of gout. The treatment comprises dieting and the usual remedies for gout. Purgatives are given freely, and full doses colchicum, piperazin, urotropin, or the alkalies; hot baths, low diet, diluent rinks, and diaphoretics are indicated. A chronic discharge from the prostic region is apt to linger; for this there is nothing better than the usual

gouty remedies and saline waters with copa In many cases it is necessary to flush the ur

of silver nitrate (1:8000).

Eczematous Urethritis.—Berkley Hill obstinate, is probably associated with gout, habit or who are beer-drinkers and who ha body. He states also that the glans penis no and that the interior of the urethra is in the sa and it is aggravated on micturition. The dis comprises injections of cold water or irrigation the administration of arsenic with the alkalie

Tuberculous urethritis is due to a tube to be seated near the vesical neck. There is there is intense pain at one spot on passing a and at times bloody. The bladder is very it and persists. The treatment includes warm oil, removal to an equable climate, and living The climate of southern California is pecu The bladder is washed out once a day wit emulsion is injected daily. Tuberculin m After a time the surgeon will probably be for pubic cystotomy.

Examination when a Urethral Dis rately the history. Obtain some of the disc slide and a slide stained, for gonococci. In: the amount of the twenty-four hours' urine and microscopically, being sure to determin the discharge discolors or stiffens linen; if if it simply glues the lips of the meatus toge if it is noted particularly or only after sexual Inquire as to pain, frequency of micturitie emissions, manner of urinating, etc. In m rectum, feel the prostate and vesicles, mas appears at the meatus after stripping the p collect a specimen and examine it. In sor a sound. Follow Valentine's advice and puce, and urethra before passing a soun and prepuce with a 1:6000 solution of c urethra with boric-acid solution and fill tl of iodoform and glycerin (5 per cent.), and a again with boric-acid solution (Valentine's by the three-glass test.

The Three-glass Test (Valentine's Pla tubes as are required to receive all the urine: contains the washings from the anterior u tubes, additional material from the bladder. expressed from the posterior urethra, pros amine the urine and the sediment in the glass. Note particularly if shreds are presen white in color and of variable length, and float in the urine. They are comosed of pus-corpuscles and of epithelial cells which have undergone fatty egeneration. Many of these shreds form in the ducts of Cowper's glands, ut the glands of the entire length of the urethra also furnish them.

Gonorrhea (Clap; Specific Urethritis; Tripper; Venereal atarrh).-Gonorrhea is an acute inflammation of the genital mucous nembrane, of venereal origin, due to the deposition and multiplication of onococci in the ceits of the membrane and a mixed infection with the cocci f suppuration. The disease is inaugurated by gonococci. After a few days r more secondary pyogenic infection develops and complications may result om the gonococci or from the bacteria causing the mixed infection. The disase attacks with the greatest ease surfaces covered with squamous epithelium. 'he gonococci enter into and multiply in the superficial epithelial and pass to etween the deeper cells, where they lodge and multiply as the superficial ells are cast off. The pus from the urethra contains epithelial cells with onococci inside of them, and also pus-cells with gonococci within them as a esult of phagocytosis. Cultures are made with difficulty. Gonococci do not ain by Gram's method but stain best with a weak, watery solution of an nilin dye. These bacteria are said not to be pathogenic to animals, Ithough some observers deny this assertion. Gonorrhea is one of the most ommon and widely disseminated diseases. Probably one-half of all sterile omen and many sterile men have been rendered sterile by this disease. t is responsible for not a few cases of abortion, for an enormous majority f female pelvic diseases, and it causes many cases of blindness from infection f children's eyes during delivery.

Gonorrhea in the Male.—In the male, clap begins within the meatus nd fossa navicularis and extends backward throughout the length of the rethra. The mucous membrane swells and becomes hyperemic, and there a discharge, first of mucus and serum, and then of pus. In severe cases ne discharge is bloody (black gonorrhea). For a week or more the inflamnation increases, then becomes stationary for a time, and then declines, ne discharge growing less profuse and thinner, a watery discharge lasting or some little time. An ordinary case of genuine gonorrhea lasts from six ten weeks, and even a case limited purely to the anterior urethra will rarely e cured within four or five weeks. During the acute stage the entire penis wells and the corpus spongiosum becomes infiltrated with inflammatory xudate. An interesting fact is that gonorrhea may induce mild septicemia ithout demonstrable complications, the condition causing, according to 'hayer ("Am. Jour. Med. Sciences," Nov., 1905), a continued fever which, erhaps, lasts a number of weeks. In true gonorrheal septicemia the blood just contain gonococci. In the case recorded by Thayer and in the case ecorded by Blumer and Hayes, cultures were obtained from the blood. conorrhea may produce grave septicemia and systemic complications. It ends particularly to attack serous membranes or other endothelial structures oints, pericardium, endocardium, pleura, tendon-sheaths, intima of vessels, c.). Among the complications are gonorrheal arthritis, myelitis, polioyelitis, and multiple neuritis. There are 3 cases of gonorrheal myositis n record (Martin W. Ware, "Am. Jour. Med. Sciences," July, 1901). Phleitis may arise. Mild endocarditis may arise or severe endocarditis may

occur, identical symptomatically with ulcer bacteria. In 6 reported cases of endocar cultures from the blood *intra vitam* (Thayer Nov., 1905). Cerebral embolism may re can occur (fluid obtained by lumbar punctu

Gonorrheal rheumatism is discussed on p is rare. Infection of the peritoneum throu majority of cases of gonorrheal peritonitis direct extension from the Fallopian tubes. in the exudates of cases of pleuritis and peri rheal origin. A child may contract gonorrhand any person may develop it by getting go

Symptoms of Acute Inflammatory Gonor of gonorrhea is from a few hours to two weeks to five days, when symptoms of the prodromal The patient notices on arising a drop of thir meatus together, and he feels some heat and i tus or in the navicular fossa. There may be nected with urination, and there is sure to be meatus is red and swollen, has a glazed appea mucopus, and the lips are glued together by t to squeeze out a drop or two. Even this ex The urine appears clear, but on shaking, se epithelial cells. Within forty-eight hours th acute stage, or the stage of increase, becor now red, swollen, and everted (fish-mouth : red and swollen; if the prepuce is long, it constricted, and in many cases very edemato and on the dorsum of the penis may be rec micturition causes severe pain (ardor urina the inflamed urethra and to stinging by described the act of micturition in acute g patient involuntarily relaxes the abdomina keeps the diaphragm elevated in order to din and lessen the size and force of the stream" (" Taylor). Because of the narrowing of the c narrow, weak, twisted, forked, or is delivered tention may result from spasm of the muscles is fully developed, the entire urethra is inf triangular ligament; there is constant un penis and perineum, increased by walking or carelessly. Insomnia is common; chorpatient is warm in bed. By chordee we me in which the penis is markedly bent. The spongiosum prevents it distending to accomi pora cavernosa, and in consequence the o micturition, with tenesmus and a profuse cr greenish, or even bloody. The discharge s and may crust upon the linen, the meatus, or plications of this stage are balanitis (inflammation of the mucous membrane of the glans penis), balanoposthitis (inflammation of the surface of the glans and the mucous membrane of the prepuce), phimosis (thickening and contraction of the foreskin, so that the glans cannot be uncovered), and paraphimosis (catching and fixation of the retracted prepuce behind the corona glandis, with such swelling of the glans and prepuce that it is impossible to bring the prepuce forward over the glans). This is a dangerous condition and it should be reduced at once. In the second or stationary stage, which lasts from the end of the first to the end of the second week, the acute symptoms of the first stage continue. The most common complications of this stage are peri-urethral abscess or phlegmon (infection of a urethral gland or of submucous structures), folliculitis (inflammation of the follicles of Littré), hemorrhage, retention of urine (which is rare), gonorrheal arthritis, lymphangitis, and diminutive bubo on the dorsum of the penis (bubonulus), solitary and painful bubo of the groin, which may suppurate, Cowperitis (inflammation of Cowper's glands), inflammation of the prostate or of the bladder, gonorrheal ophthalmia, and chordee (painful erection with downward bending of the penis). In the third or subsiding stage the symptoms gradually abate, the discharge becoming scantier and thinner, and finally drying up. This stage is of uncertain duration, and in it there may occur epididymitis, or inflammation of the epididymis. Among possible complications we may mention peri-urethral abscess or phlegmon, Cowperitis, cystitis, prostatitis, bubonulus, folliculitis, gonorrheal arthritis (page 645), infective endocarditis, tenosynovitis, pyelitis, puruent ophthalmia, perichondritis, and peritonitis. Every urethral discharge should be examined for gonococci in order to make a positive diagnosis. This examination is made several times during the progress of the case, so as to determine when the organisms disappear. The examination can be easily made. Place a drop of discharge upon a cover-glass, lay another over-glass over this, and slide the glasses apart. Dry and fix the slides in the lame of an alcohol lamp. Bring the cover-glasses in contact with a saturated solution of methylene-blue in 5 per cent. carbolic acid water. The stainingmaterial is allowed to remain in contact with the slides for five or ten minutes, the glasses are washed with water, are then placed in a solution of 5 drops of acetic acid to 20 c.c. of water, and kept there "long enough to count one, two, three slowly," and again washed with water. Examination with the microscope shows the gonococci stained blue.\* In doubtful cases, when the microscope fails to show gonococci, make cultures. Cultures should always be taken from a discharge in a child, from the fluid of an inflamed joint, from the discharge in gleet or purulent ophthalmia, and from the blood in obscure infections.

Subacute or catarrhal gonorrhea develops in men who have previously had gonorrhea, as a result of prolonged or repeated coition or of contact with menstrual fluid or leukorrheal discharge. There is profuse mucopurulent discharge, very little pain on micturition, but seldom chordee or marked irritability of the bladder.

Irritative or Abortive Gonorrhea.—In this disease the symptoms, which are identical with those of beginning clap, do not increase, but are apt to disappear within ten days.

<sup>\*</sup>Schütz's method, as set forth by R. W. Taylor in his work upon "Venereal Diseases."

Chronic Urethral Discharges.—Chromay follow gonorrhea, is characterized by the of clear, tenacious liquid. This discharge be of sexual excitement or the abuse of alcohol.

The persistence of a small amount of mi zation of inflammation in one spot or the prosuperficial ulcer, characterizes chronic gond on urination; erections produce aching pain redness and swelling of the meatus. All t sexual excitement, by coitus, by violent exerc

Gleet .- If a chronic urethritis lasts over gleet the lips of the meatus are stuck together them discloses a drop of opalescent mucopur discharge is rarely found. The discharge is it stains the linen distinctly, and contains times gonococci. The urine is clear and co and comma-shaped hooks. The discharge contains amyloid corpuscles. There are in the back, and dribbling of urine, and a large caliber, or at least will discover that flammatory infiltration. A discharge may tatitis. In this condition there are freque weight or dull pain in the perineum; diminist of urine; there is often a tendency to sexual sion. In prostatorrhea a milky discharge ga and flows during muscular effort or while th is stained but slightly and the lips of the m waking. There is a history of masturbation is not aggravated particularly by alcohol or anterior urethritis there is a discharge fro gether of the lips in the morning. there is no discharge of pus from the me. made, it will be found that in a case of the first portion will be cloudy and show terior urethritis of not very long standing, both the first containing clap shreds, the last h chronic case neither sample will be cloudy, shreds. In gleet the rigidity of the urethra quantities of urine after each act of micturiti This retained urine decomposes and adds t alcohol, sexual excitement, or sexual intercon

Treatment of Acute Gonorrhea.—Gene touching the parts and dry them on an indication upon the face. Wear a suspensory bandage cially bicycle riding, and also wet. Moder patient must not only refrain from sexual in himself to indulge in sexual excitement, and malt, vinous, or spirituous, unless he is a hear case we should permit the moderate use of w

Some men become actually ill without their regular daily stimulants and such men should have them in moderation. Some surgeons permit the moderate use of claret to all patients. At least twice a day wash the penis for five minutes in a cup of warm water containing 3j of salt. Passing the urine while the penis is immersed in warm fluid lessens ardor urinæ. If the foreskin is long, catch the discharge on a bit of absorbent cotton caught under the prepuce and change it at each act of micturition. If the foreskin is short, cut a small opening in a square piece of old linen, slip the linen over the glans, catch it back of the corona, and bring the ends forward with the prepuce. Never permit the cotton or linen to stick fast and plug up the lips of the meatus. This may be prevented by applying sterile vaselin to the lips of the meatus. If the glans is completely naked, pin an old stocking foot upon the undershirt, put absorbent cotton in the toe, and place the penis within this bag. Never tie or fasten any material about the penis. The patient should drink freely of plain water or of water containing a little bicarbonate of sodium. He should obtain one bowel movement every day. I am accustomed to direct the patient, in accordance with Guitéras's rule (Begg, in "Phila. Med. Jour.," June 7, 1902), to avoid tea, much coffee, pickles, spices, condiments, rhubarb, tomatoes, and asparagus. Carbonated beverages, salt, preserved fish, and cheese are detrimental. Excessive smoking is forbidden.

Abortive treatment may be tried if the case is seen early. The use of strong solutions of powerful germicides has been abandoned because of the great pain they produce and the inevitable subsequent crippling of the urethra.

Abortive treatment is applicable only to specially selected cases and even then usually fails. It should never be used after the gonococci have invaded the submucosa, but only during the prodromal stage, when it is hoped that the germs are upon and not in the mucous membrane. This stage usually lasts but a few hours, usually not over forty-eight. The patient generally presents himself after this period is passed. When the symptoms as described in the prodromal period prevail, the abortive treatment may be tried, after explaining to the patient that it will cause some pain and discomfort and in the end may fail or even aggravate the inflammation.

Germicides may be used and with some chance of killing the infection, for as yet the organisms are growing upon the superficial strata of epithelium much as a sod of grass upon soil. When the deeper structures have been invaded it is folly to attempt to abort.

The method advocated by White and Martin and which has proved successful in Prof. Orville Horwitz's clinic in a very limited number of selected cases is as follows: After urination four drops of a 4 per cent. solution of eucain is injected into the urethra; after which 1 or 2 drams of 1 per cent. solution of protargol is instilled and retained for three minutes. The injections are repeated every two hours while awake.

Each time the bottle is half emptied it is replenished with sterile water to its full capacity, until the end of the third day. If successful, recovery is accomplished in about seven days. Should a mucoid discharge persist an antiseptic astringent injection is employed to complete the cure. During the treatment the patient must be kept at rest. The diet should be bland and light and the usual balsamic remedies are administered. If the symptoms become hyperacute, stop the treatment at once and give a sedative.

Another abortive method is the use of hot r mate solution (r: 20,000), 2 pints being reday. If in seventy-two hours the sympter abortive treatment should be abandoned. It certain that there is no real abortive treatment be efficient, would have to be carried out if the epithelial cells; in other words, would redistinct symptoms of the disease appear.

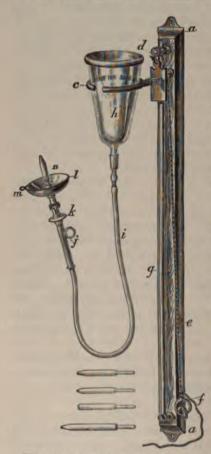


Fig. 798.—Valentine's urethral and intravesical irrigator: a, Board with attachments to be screwed to wall; c, open collar; d, pulley; e, cord; f, ring to suspend percolator; g, brass rod; h, percolator; i, rubber tube; f, ring for fourth finger; k, flange to graduate pressure; k, shield;  $m_i$ , ring to suspend shield;  $n_i$  nozzle attached.

our co abortiv a case aborted with so tassium ment. evidem and b and cl disease to two treatm case.

Irri ent or method filled v ganate patient seated rests u the ch is joine tube. the me to rui force fluid i meatus The a gated

gated feet ab

In terior reserve feet ab

tight about the nozzle, and the fluid overcommuscles of the urethra and the bladder spl If the muscles do not quickly relax, contin

\* Ann. d. mal. d. org. gen.-urin

several minutes, when relaxation will usually occur; but if it does not do so, tell the patient to breathe slowly and deeply, and to make efforts at urination (Valentine). When the bladder is full the tube is withdrawn and the patient micturates. This procedure is practised once or twice a day for five or six days, or even longer, and the strength of the solution is gradually increased up to r: 1000. It has been claimed that after one or two weeks of this treatment gonococci permanently disappear in the majority of cases. Fig. 798. shows the irrigator devised by Ferd. C. Valentine. Valentine, of New York,\* has constructed the following table, which is of use to a practitioner who wishes to employ irrigations with permanganate of potassium in the treatment of acute gonorrhea:

Vinet Jan C.	int minte	Antarian ind	-												
First day, fir		Anterior irri												30	
First day,	7 P. M.	Anterior	**											40	
Second day,	9 A. M.	Anterior	**			*		*		*	*		I:	30	00
Second day,	7 P. M.	Anterior	**								*		I:	40	00
Third day,	9 A. M.	Intravesical	**											60	
Third day,	7 P. M.	Anterior	**											50	
Fourth day,	9 A. M.	Intravesical	ic											50	
	,	Intravesical	66											50	
Fourth day,	7 P. M.	Anterior	**											20	
Fifth day,	Noon.	Intravesical	44											50	
Sixth day,	Noon.	Intravesical	**												
Seventh day,	Noon.	Intravesical	**											50	
Comment of the same of		Total market	66											50	
Eighth day,	9 A. M. 3	Intravesical	16											50	
	(													30	
Eighth day,	7 P. M.	Intravesical	**											50	
m.Barre amy	1	Anterior	44	1	*	*		*	*				1:	20	00
Ninth day	n . w 1	Intravesical	14										1 :	40	00
Ninth day,	9 A. M.	Anterior	66			6	2	*		*	*	4	I:	IO	00
Mind day		Intravesical	44				4.				4.		I:	40	00
Ninth day,	7 P. M.	Anterior	88											10	
	9 A. M.		44											40	
Tenth day,		Anterior	44											10	
	1	Intravesical	- 44											50	
Tenth day,	7 P. M.	Anterior	**											50	
	(	FAIRCHOI				*		*			-	*	-	20	-

For full directions regarding this method see Valentine's excellent book, "The Irrigation Treatment of Gonorrhea." If a stricture exists, it is not advisable to employ this treatment. Excellent results can be obtained by irrigations with fluid containing silver nitrate (1:12,000 to 1:8000).

When a patient is treated by irrigation, after the entire subsidence of acute symptoms, a thin, colorless discharge may persist. This can be cured by the use of astringents. Two or three times a day an astringent is injected by means of a half-ounce syringe. Dalton's formula is very useful: Zinc oxid and lead acetate, of each, ½ gr. to 3 gr.; tincture of catechu, from mx to mxxx; glycerin, from 3ss to 3j; and water to 3j.

Many writers oppose the irrigation treatment, claiming that it increases the liability to complications, especially prostatic infiltration, and enhances the danger of recurrence. I believe in the method. I do not think it shortens the duration of the disease, but do believe that it mitigates its intensity, makes the patient much more comfortable, and quickly causes the discharge to become mucopurulent. That it increases complications and the danger of reinfection is very doubtful. Much of the trouble which has followed its use has been due to raising the reservoir to too great a height.

<sup>\* &</sup>quot;The Irrigation Treatment of Gonorahea."

Irritative gonorrhea will subside in a few days. The above directions should be followed, and the anterior urethra should be washed out several times daily with peroxid of hydrogen, or irrigated once a day with a hot solution of permanganate of potassium (1:4000). In catarrhal gonorrhea, at once order injections (1 grain to the ounce of sulphate of zinc; or zinci sulphas gr. viij, plumbi acetas gr. xv, water 3viij; or gr. v of sulphocarbolate of zinc to 3j of water; or White's prescription of 3j each of acetate of zinc and tannic acid, 3iij of boric acid, 3vj of liq. hydrogen. peroxid.). For injecting use a blunt-pointed hard-rubber syringe of a capacity of three or four drams. Let the patient urinate and then sit on a chair, his buttocks hanging over the edge; throw a syringeful of the solution into the urethra and let it run out at once and throw in another syringeful and hold it in from three to five minutes.

In ordinary acute gonorrhea the old rule was to order balsams. The common custom is to give two capsules three times a day, each capsule containing 5 grains of salol, 5 grains of oleoresin of cubebs, 10 grains of balsam of copaiba, and I grain of pepsin. Clinical observation indicates that the balsams are of distinct value in gonorrhea. When used early, the discharge tends to become mucopurulent and the acute symptoms subside (S. Behrmann, in "Dermatologisches Centralblatt," Berlin, Nov. and Dec., 1001). Many practitioners will not use balsams until the third week. Bacteriological studies indicate that copaiba, when eliminated in the urine, has a certain amount of power in inhibiting the growth of gonococci, but that cubebs and sandal have not such power. Yet sandal is more useful than copaiba as a remedy. Salol is distinctly germicidal, hence it is given with the balsams. In a case treated with balsams an astringent injection is usually employed. The injection is used two or three times a day, immediately after micturition. As the inflammation subsides increase the strength of the injection. A good plan is to order an eight-ounce bottle and eight half-grain powders of sulphate of zinc. Direct the patient to fill the bottle with water, in which one powder is dissolved; when this is used dissolve two powders in a bottleful of water. and so progressively increase the strength. When the discharge ceases stop the injections gradually. Whenever a syringeful is taken from the bottle 3 syringeful of water is put into the bottle, and thus pure water is soon obtained. at which point injection is discontinued. If an astringent injection causes much pain, use a sedative injection-3ij of boric acid, gr. viij of aqueous extract of opium, and 3viij of liquor plumbi subacetatis dilutus. I have had as much success with the above simple method as with the most complicated of plans. Complication and complexity are not criterions of usefulness.

Argonin, which is a combination of albumin, silver, and an alkali, is highly recommended by some authors as a local remedy for gonorrhea (Schäffer, Guthiel). A solution of this material is non-irritant, the silver is not precipitated by chlorids, and the agent destroys gonococci. It is used by injection or irrigation. If used by irrigation, employ a 1:500 solution twice a day. If used as an injection, employ a 1:200 solution six or eight times a day. When the discharge is found free from gonococci and remains free for three days, stop the argonin and use an astringent injection.

Protargol, metallic silver combined with a proteid, is a yellow powder soluble in water, the solution not being acted on by light. It is a non-irritant

germicide. Neisser, after demonstrating the presence of the gonococcus,

administers protargol by injection, the first injections being of a strength of 0.25 per cent., the strength being gradually increased to 0.5 per cent., and finally to I per cent. In the beginning he orders three injections a day, each injection being retained from fifteen to thirty minutes; after several days, when the symptoms improve he gives only one or two injections a day, and these are continued for ten days after gonococci disappear from the discharge. After protargol is abandoned an astringent injection should be used for a time. Some surgeons use a 1:1000 solution of protargol, and irrigate the anterior urethra and flush the bladder twice a day. The most powerful and useful of the silver salts is argyrol, or silver vitellin. This salt was discovered by A. C. Barnes and H. Hiller ("Med. Record," May 24, 1902). It is an extremely soluble preparation, contains 30 per cent. of silver, does not coagulate albumin, and is not precipitated by chlorids. When injected into the urethra it enters deeply into the mucous membrane and is powerful in destroying gonococci. (See "A Clinical Study of a New Silver Salt in the Treatment of Gonorrhea," by H. M. Christian, in "Med. Record," vol. lxii, 1902.) In most cases gonococci disappear within two weeks. The injection used at first may be of a strength of 2 per cent. The drug should be retained in the urethra four or five minutes, and three or four injections should be given each day. The strength of the injection can be gradually increased to 5 per cent. or even more. Picric acid has been highly commended as an injection. The strength of solution is 1:200, and it is to be retained in the urethra three or four minutes (de Brun's method).

Methylene-blue internally is occasionally of service in gonorrhea. A capsule containing gr. ij of the drug is given three times a day. It makes the urine greenish-blue and occasionally induces strangury. Urotropin renders the urine sterile. Salicylate of sodium may be of value late in the case.

Christian's plan of treating acute gonorrhea is very useful. It is as follows: Two solutions are used during the first ten days. Three times a day a solution of permanganate of potash is injected (gr. ½ of permanganate of potash in 8 ounces of water), six syringefuls being used at each séance. After a washing with permanganate protargol is injected (gr. x of protargol to 3iv of water) and retained ten minutes. At the end of four days the strength of the protargol is increased to gr. xx in 3iv and the strength of the permanganate to 1:4000. During the third week abandon the above-mentioned solutions, put the patient on balsams, and use an astringent injection. Christian uses gr. x of sulphate of zinc, gr. ij of subcarbonate of bismuth, 2 ounces of solution of hydrastis, and 4 ounces of water. Cure is obtained in six or seven weeks.

In his clinic in Jefferson Hospital my colleague, Prof. Horwitz, employs the following plan of treatment: A capsule containing balsam of copaiba, salol, oil of sandalwood, and methylene-blue is given half an hour after each meal:

The patient begins at once, three times a day, the use by hand injection of a 10 per cent. solution of argyrol.

## 1348 Diseases and Injuries of the Ge

At each day injection the fluid is retaine At the bedtime injection the fluid is retain only about 3j is injected at a time, but as t to fluid distention the amount is gradually given.

Argyrol is less irritant and, it is said, m other preparations, but it cannot penetrate de value except in the period of onset or early in object to argyrol because it leaves a dark s comes in contact, but this stain can be easil a 1: 1000 solution of corrosive sublimate.

When the stage of decline begins (toward combined astringent and antiseptic treatment

The capsules of methylene-blue, copaiba jections of argyrol are discontinued. A capsu oil of sandal, and balsam of copaiba is given be urotropin is given after each meal. An inject is given three times a day. This remedy is The strength is gradually increased until a 1 p end of the fourth week the patient has reacapsules of sandal and salol are substituted fo and an astringent injection is ordered. The f by J. Wm. White, is very satisfactory:

When the mucoid condition predominates useful:

R. Zinci sulph.
Plumbi acetati.
Glycerol tannin
Hydrastin (Lloyd's)
Mucil acaciæ.
Aquæ destil
Sig.—As injection.

The formula of the "injection Brue" is as

R. Plumbi acetat.
Zinci sulphat.
Ext. krameriæ fl.
Tinct. opii
Aquæ destil
Sig.—As injection.

When all symptoms have disappeared, the Whenever a syringeful of the fluid is taken to

water is put in. When the fluid becomes pure water, the injection is discontinued. The capsules are stopped by gradual diminution in the number of daily doses. For three weeks after the entire disappearance of all symptoms alcohol is forbidden and sexual indulgence is prohibited. Should a relapse occur the patient is at once placed upon treatment as for the acute stage, and when the stage of decline again ensues he is placed on the previously mentioned antiseptics and astringents. Relapses are caused by a localized lesion or lesions in the anterior or posterior urethra, hence as soon as all acute symptoms subside an endoscopic examination is to be made and proper treatment is to be applied to the localized lesion. If during the treatment of gonorrhea a complication develops, local treatment of the urethra is at once discontinued and constitutional treatment suited to the new condition is prescribed.

If the onset of gonorrhea is marked by violent inflammatory symptoms (chordee, hemorrhage, severe pain, swelling, profuse purulent discharge), local treatment of the urethra is contraindicated.

If the invasion is hyperacute, no local treatment of the urethra is permissible until the disease assumes the character of ordinary gonorrhea.

Not unusually gonorrhea passes into a low grade of anteroposterior urethritis that proves most rebellious to treatment. This condition is especially common when a too stimulating treatment has been used. A mild astringent injection is used three times a day. Every second or third day an injection of nitrate of silver (1: 4000) is given. If the silver salt sets up an acute inflammation the treatment used in the acute stage of gonorrhea is given until the symptoms abate.

A valuable plan in rebellious anteroposterior urethritis is daily irrigation of the anterior urethra with a warm solution of permanganate of potassium (1:6000), followed by the passage of a soft catheter and the filling of the bladder with a like solution. The patient empties his bladder after the catheter is withdrawn and thus flushes the entire urethra with the permanganate. The strength of the solution is gradually increased up to 1:2000.

Weiss uses corrosive sublimate (1: 20,000) in the manner just described. It is particularly valuable in cases of bacterial contamination, the gonococci having disappeared.

Treatment of Complications.—Ardor urinæ is relieved by urinating while the penis is immersed in hot water and by administering an alkaline diuretic. Chordee requires a bowel movement in the evening, and sleeping in a cool room, under light covers, and on a hard mattress; bromid is given several times daily, and a considerable dose is given at night; it may be necessary to use suppositories of opium and camphor or to give hyoscin. Balanitis requires frequent washing with warm water, drying with cotton, and dusting with borated talc or with boric acid and subnitrate of bismuth (1:6). Balanoposthitis requires soaking in hot water, and injections of black wash under the prepuce until edema of the foreskin subsides, and then cleanliness and the application of a drying powder. Phimosis requires soaking the penis in hot water, and injections of hot water beneath the foreskin, followed by black wash, If this fails, circumcision must be performed. If paraphimosis occurs, grasp the head of the penis with the left hand, squeeze the blood out, and try to push the head back, while with the right hand the penis is pulled upon as if

the surgeon intended to lift the individual by collar on the dorsum with scissors; or, what sure, incise each side of the prepuce between the frenum. Bubo requires the application ment, the use of a spica bandage, and rest. opened or aspirated. Acute posterior urethrisymptoms are severe, by rest in bed. If the given; if they do, they are withdrawn. Uro patient is placed upon a milk-diet with orders Alkaline fluids do harm by favoring ammonia Injections and irrigations are abandoned. I trolled by suppositories of opium and bell occurs, have the patient urinate while in a h catheter. Acute vesiculitis is treated as is ac litis is considered on page 1369. Pyelitis is t wet cupping of the loin, or milk-diet, the use of quantity of bland liquid, and the administration liculitis is treated by rest and the application neum (if that be the part involved). If pr Later the follicle may be dissected out or the follicle opens into the urethra it may be co Peri-urethritis is treated by rest and hot appl sion must be made. If the abscess is perm rest and hot fomentations may be used, but travasation make an external incision. Con way as peri-urethritis. Gonorrheal rheumat Acute prostatitis and cystitis require confiner of diuretics, hot applications to the perin positories of opium, and belladonna or ic the discontinuance of balsams and injection urotropin or salol. Abscess of the prostate retention of urine the patient should try to pa if this fails, a soft catheter is used. After relie to bed and apply hot sand-bags as for acute requires cold hip-baths, cold-water enemata, diet, avoidance of alcohol and over-exertion neum, and the relief of stricture or phimosis derived from passing a soft bougie covered v per cent. ointment of protargol. If epididy bed, abandon injections, shave the hair from elevate the testicles, and apply an ice-bag. C and suitable doses of bromid of potassium twice a day of 20 drops of guaiacol in 3j of relief. When swelling lingers, after tenders with adhesive plaster. A lingering case is I iodid of potassium and the local applicati ophthalmia secure a watch-crystal over the in a darkened room, rub the infected conjunc

2 per cent. solution of silver nitrate, wash out the affected eye often with hot boric-acid solution, keep the pupil dilated with atropin, leech the temple, and

give purgatives. Always send for an ophthalmologist.

When is Gonorrhea Cured?—When actual discharge ceases, a patient considers himself cured and yet he may have residuals of infection which are liable at any time to awaken into activity and produce anew an acute condition. Gonococci are frequently retained in the urethral glands and follicles or in areas surrounded by indurated mucous membrane. A man is considered to be well when shreds and pus disappear from the urine, when an examination of expressed mucus on three successive days fails to find gonococci, and when there has been no discharge for ten days. Furthermore, we must be sure that the prostate, Cowper's glands, and the seminal vesicles are free from disease.

Treatment of Chronic Gonorrhea and of Chronic Urethritis following Gonorrhea.—The first thing to do is to determine the cause of the prolongation of the discharge. Valentine's list of causes should be borne in



Fig. 799.—Bougie-à-boule.

mind ("Med. Record," June 29, 1901). They are as follows: (1) Lack of treatment; (2) misdirected treatment; (3) insufficient treatment; (4) overtreatment; (5) infraction of dietetic or hygienic regulations; (6) constitutional disturbances; (7) congenital or acquired deformities and complications; (8) involvement of the urethral adnexa; (9) marital reinfection. In a case in which a discharge persists or recurs, the symptoms and general condition must be closely studied, the discharge must be examined microscopically, the condition of the urine must be determined, and the urethra must be explored.

Exploration of the urethra is inaugurated by inspection and external palpation. Palpation detects induration, peri-urethritis, follicular abscess or inflammation, Cowperitis, etc. The prostate and seminal vesicles are examined by a finger in the rectum. The interior of the urethra is explored with a soft bougie-à-boule (Fig. 799). On withdrawing this instrument the shoulder catches in any contracture. It is to be borne in mind that a large steel sound can often be introduced with ease when the bougie-à-boule makes evident that a contracture exists. The emergence of the instrument is arrested by a patch of thickening, a granular area, a zone of epithelial proliferation,

a papilloma, or a stricture. In fact, anythic caliber interferes with the withdrawal of the b



Fig. 800,-Valentine's urethroscope.

mentarium. I use Valentine's instrument and



Fig. 801.-Valentine's urethrose

800-803). The anterior and posterior urethrowith the utmost ease. Before inserting a ureth



Fig. 802.-Valentine's obtu

recumbent and cleanse the foreskin, glans, an in the section on Cystoscopy. Insert a tube wl



Fig. 803.-Valentine's light of

first cleansing the tube and obturator by burni the tube to the anterior layer of the triangu obturator and insert the light. Turn on the light, mop the urethra with bits of cotton wrapped on a stick, and slowly withdraw the tube, examining the urethra as its walls fall together back of the retracting tube. After withdrawal of the tube irrigate the anterior urethra. To examine the deep urethra, carry the instrument through the prostatic urethra. After the examination give an intravesical irrigation.

When the cause of a discharge is once determined, rational treatment can be instituted, and to determine the cause the electric urethroscope is indispensable. An erosion of the mucous membrane or a granular patch requires touching from time to time with a solution of silver nitrate (1 or 2 per cent.). These applications are made through the tube of the urethroscope. A

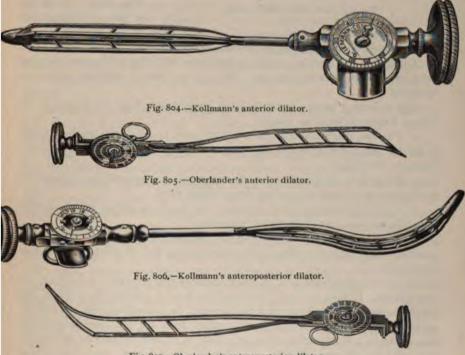


Fig. 807. - Oberlander's anteroposterior dilator.

stricture or an infiltration is treated by gradual dilatation. This combines pressure and massage. If the caliber of the urethra is less than No. 21 of the French scale, conical steel sounds are used twice a week. If there is much hyperesthesia they are retained but a brief time; but as hyperesthesia diminishes the period of retention is lengthened, until an instrument can be kept in place without causing severe suffering for ten or fifteen minutes. It is not desirable to use cocain, as it is distinctly dangerous, obtunds the sensibility so that undue violence may be used, and increases the post-operative inflammation. Before and after using an instrument the urethra must be cleansed as previously directed (page 1338).

When the urethra becomes tolerent to it is employed to act particularly on the area of treatment the caliber of the urethra is equal French scale, it is rarely necessary to precede sounds. Figs. 804, 805, 806, and 807 show should be inserted in a sterile rubber cover.



Fig. 808.-Kollmann's gland syringe.

with lubrichondrin or synol soap. If a tw a four-bladed dilator must be subsequently

A dilator is cleansed by scrubbing its bla them in alcohol, withdrawing, and burning strument.

The following rules are of the first im "Med. Record," June 29, 1901):

The first dilatation must stop at that to further dilatation is felt by the operator separates the blades.

Dilatations, if done by a novice, mu be repeated no oftener than every three or fo

Each dilatation, in point of time, mus two minutes over that of the preceding session

 No dilatation must exceed one-half nu attained at the next prior séance, regardless of be present.

As a rule, glandular and follicular infilithe dilator. If they are not, they must be urethroscope. The interior of a follicle mawire or subjected to electrolysis, or touched silver nitrate. A thickened crypt, or gland, tion, may be slit with a knife. A polypical cautery, or special forceps. In a chronic which the inflammation is superficial and involved, irrigations, urethral and intravesical (See Valentine's treatise on "The Irrigation Local Complications and Sequels.")

In any lingering case of gonorrhea exami treatment for oxaluria, lithemia, or phospha tions exists. Such morbid states of the uring great prolongation of the inflammation. In up by inflammation of the seminal vesicles (p

Gonorrhea of the anus and rectum

occurs. It may result from pederasty, or in a woman from a flow of infectious material from the genitalia to the anus. It causes severe burning pain, aggravated by defecation. The parts are red, swollen, and tender. The discharge is profuse, being at first cream white, and then thicker and greenish. The diagnosis rests upon the history and the finding of gonococci in the discharge. The disease rarely extends above the anus.

Treatment.—If the anus only is involved, spray several times daily with peroxid of hydrogen, wash with salt solution, irrigate with permanganate of potash (1:4000), dust with talc powder, and interpose a piece of iodoform gauze between the inflamed surfaces. An ulcer, a fissure, or an excoriation is touched with lunar caustic. If the rectum becomes involved, secure a daily bowel movement and irrigate the rectum twice a day with boric-acid

solution or permanganate of potash (1:4000).

Gonorrhea of the Mouth.—This is a very uncommon malady. It occurs in infants more often than in older people. Infection in infants may take place during birth if the mother has gonorrhea. The symptoms are those of violent stomatitis. The diagnosis is suggested by the condition of the mother and is proved by finding gonococci in the discharges from the mouth.

Treatment.—Wash the mouth frequently with boric acid and listerine (gr. xlviij to 5viij), and swab the diseased areas at intervals with a 10 per cent. solution of argyrol.

Gonorrhea of the Nose.—It is alleged that this condition can arise,

but an absolutely authentic case does not seem to be on record.

Gonorrhea in the Female.—There is much dispute as to the parts infected. Some observers maintain that the vaginal epithelium never contains gonococci and that gonococci found in a vaginal discharge have come from the cervix or uterine canal. Beyond a doubt, however, when young women who have not borne children contract gonorrhea the vulva and vagina usually suffer. In older women and in women who have borne children the vaginal tissues are altered and the cells are not nearly so prone to infection; hence in such subjects the vagina often or usually escapes. The initial infection is in many cases in the cervical canal, in some in the vulva or urethra. No matter what part was first attacked, other parts usually become quickly involved in the acute process. The urethra is involved in almost every case. Chronic gonorrhea is prone to linger in the urethra, in the glands of Bartholin, in the cervical canal, or within the uterus or in the Fallopian tubes. The great danger of gonorrhea in the female is in the development of ascending infection of the lining membrane of the uterus, which may reach the tubes, ovaries, and peritoneum.

When infection occurs during pregnancy or when pregnancy occurs during infection of the cervical or uterine canal, abortion may take place. Again, a pregnant woman may not abort but may go on to term and the child may receive a conjunctival infection during delivery and rapidly develop

purulent ophthalmia.

In some cases when pregnancy occurs during the existence of gonorrhea, the disease seems to pass away and yet the child gets conjunctival infection during delivery or the mother subsequently develops pus-tubes.

Treatment.—Place the patient in bed du ease, give hot hip-baths, keep the bowels of tives, insist on a fluid diet consisting chiefly thra by having the patient drink considera external genital organs should be sprayed v two or three hours, and after spraying should and dusted with equal parts of starch and powdered stearate of zinc. Pads of cotton fused to catch the discharge. If urethritis exalkalies, balsams, and astringent urethral inj

When the acute symptoms have somewhat made to prevent ascending infection from the membrane of the canal may be cureted award bolic acid or nitrate of silver. A wiser plate daily with iodin or a 10 per cent. solution of portion of the cervix at the same time with irrigated twice a day with a warm solutio (1:4000) and is lightly packed with iodofor particularly involved, treat that part by applically or paint the vulva with silver solution vaginal gland suppurates, open it.

If vaginitis exists and continues in spite of wash out the vagina every two hours, firs bicarbonate of sodium, next with Oj of hot astringent solution (a teaspoonful of lead sulphate, a teaspoonful of alum, or four teasphot water) (White). As the attack subsides, containing gr. v of tannic acid. In some nitrate (1:200) or of argyrol (10 per cent.), (8 per cent.) moistened with boroglycerid (Le

In chronic cases of urethritis use strong irrigate the urethra and bladder with silver

For uterine gonorrhea observe the same out the uterus with tincture of iodin or nitra of iodoform gauze.

Gonorrhea in Children.—Male Children common. When it affects children under twa bandoned and diseased female having brotact with her sexual organs. It may result frials into the penis. The symptoms are similed met with in an adult. The finding of the golute legal proof of the existence of gonorrheathat boys may suffer from catarrhal urethritistants, from balanoposthitis, or from overacidation by the growth of the suspected micro-organical support of the suspected micro-organical supp

The *treatment* consists of confinement to be drinks, light diet, etc. Circumcision is necessal acute symptoms subside, injections are used as Female Children.—Gonorrhea is more common in female children than in male children, and the vagina is involved as well as the vulva and urethra.

A female child may suffer from catarrhal inflammation of the vulva, as a result of the contact of foul urine, of feces, of the presence of seatworms, or of neglect of bathing. In such a case the vagina and urethra escape. Involvement of the vagina and urethra strongly suggests gonorrhea. A recently born child or a young infant may acquire gonorrhea directly from a diseased mother, or indirectly, by pus upon linen, the mother's fingers, etc. A diseased nurse may infect the baby. Older children who have ceased to nurse may get the disease from infected linen, bathtubs, etc., and may by these means infect child after child in an institution. Now and then the disease arises by a diseased man or woman deliberately bringing the child's private

parts in contact with their own diseased organ.

The disease is acute: the urethra, vulva, and vagina are usually involved; the discharge is profuse, purulent, and often bloody. During the first day or two the discharge exhibits leukocytes but no gonococci, and the normal flora of the urethra disappear; later gonococci appear (Harmsen, "Zeits. f. Hyg. u. Infektionskr.," 1906, vol. iii). Microscopic examination of the discharge is absolutely necessary. Dry cover-slip preparations are made so as to obtain clap shreds from the discharge. An attempt should be made to obtain cultures. The gonococcus is very difficult to maintain in culture; it must be frequently transferred, and it grows best in an incubator at a temperature of 36° C. No attempt is made to grow it upon ordinary culture-media. The finger may be sterilized and punctured, blood thus obtained being smeared upon ordinary agar. Upon this composite material growth can be obtained. Animal blood serum is not a good medium, but human blood serum is (Lehmann and Neumann). Human blood serum is obtained by opening a vein or from a fresh placenta.

Lehmann and Neumann ("Atlas and Principles of Bacteriology") find the following a satisfactory medium: Agar, containing 1 per cent. peptone and 5 per cent. glycerin, which has been liquefied and cooled to 50° C., is mixed "with one-half its volume of ascites fluid or the fluid from ovarian cysts." Plate cultures and streak cultures should be made. This excessive care in proving the presence of the gonococcus is imperatively necessary in female children because of the medico-legal questions which may arise in such

a case and also because of the danger of infecting others.

Surgeons are apt to be doubtful about the diagnosis in many supposed cases of gonorrhea in female children. The clinical picture may simply be that of catarrhal vulvo-vaginitis, it may be that of gonorrhea. The finding of the gonococcus is regarded as conclusive from a clinical standpoint, but not from the legal point of view. Again, as Taylor points out, in some cases in which the clinical and microscopic evidence seems to prove the existence of gonorrhea no proof can be obtained that the condition is of venereal origin, and that in some cases in which everything indicates that the disease began as a catarrhal vulvo-vaginitis, a condition seemingly identical with gonorrhea has arisen. Obtaining a culture of gonococci is conclusive. The treatment consists in taking every care to prevent diffusion of the infection to others and

to the patient's own eyes. She is put to bed, upon milk, etc. Irrigations of bicarbonate of by protargol (r:5000, according to White a

injections are indicated.

Treatment of Gonorrheal Arthritis and End in the Journal A. M. A., Jan. 27, 1906, page Torrey described the method of preparation the treatment of gonorrheal arthritis. This ser factured by a good chemical company, seems treatment of gonorrheal infections of joints, to tures. Dr. Thomas W. Stellwagen, of the gen son Hospital, has used the material in a series of gonorrheal arthritis with gratifying results.

Preparation of the Serum.—To quote from ports: "Rabbits were at first used exclusively in a very potent serum may be obtained from to the serum itself is decidedly toxic for some rather alarming reaction. This matter will be detail. In order to obviate this serious object goats and sheep. Similar objectionable programmer found to be present in goat serum, but from entirely absent. Accordingly in later work used. They should be full grown, uncastrate animals it has been found advantageous to p first inoculation may consist of the twenty-18 square inches of solid culture medium, emologic saline solution, and heated for one-hall

In Stellwagen's studies and use of the ser results were obtained by giving the injections as possible and, further, to give them every d noticed were now and then an eruption of who slight headache and itching, with a trivial r cases generally showed marked improvement a The serum also seemed to be of use in other prostatitis, and epididymitis. Stellwagen mai ble adjunct in treatment, especially where the oto produce a result. Its great claim to proarthritis and other synovial infections, in valuable.

The serum must not be confused with uncertain. In the clinic of the Jefferson Horbeen used, they did not produce the happy reascribed to them.

Stricture of the urethra, or narrowi divided into *inflammatory*, *spasmodic*, and *a matory* or *congestive* stricture is not a stricture ing of the mucous membrane.

Spasmodic stricture does not exist alone, be a hyperesthetic urethra, or an inflamed bladd Organic stricture is a fibrous narrowing of the urethra, due, as a rule, to chronic gonorrheal inflammation or to traumatism. True organic stricture is very rare in children, but can occur. Abbe reported a case of impassable stricture in the deep urethra of a male child two and one-half years of age, due to urethral gonorrhea. There were also two strictures of the anterior urethra. External urethrotomy was performed. Traumatic strictures occur in the bulbous or membranous urethra, and are due generally to force applied to the perineum, the urethra being squeezed between the subpubic ligament and the vulnerating body. Strictures resulting from gonorrheal inflammation occur in the penile, bulbous, or membranous urethra. Stricture never forms in the prostatic urethra except as a result of traumatism. Recent non-traumatic strictures are soft and are easily distended. Old strictures and traumatic strictures are very dense. A resilient stricture is one which contracts quickly after dilatation. The nearer a stricture is to the meatus, the more fibrous it is.

A congenital stricture is congenital narrowness of a portion of the urethra, usually the portion near the meatus. The more fibrous a stricture is, the more it narrows the urethra and the less dilatable it is. A stricture may be annular (forming a ring around the urethra), tubular (surrounding the urethra for a considerable distance), or bridle (when a band crosses the urethra from wall to wall). A stricture of large caliber will admit an instrument larger than a No. 15 French sound. A stricture of small caliber will not admit a No. 15 French sound. An impermeable stricture will not admit the passage of any instrument. Impermeable is more or less a relative term. A stricture may be impermeable when an anesthetic is not used, and permeable when the patient is anesthetized, or may be impermeable to one surgeon, but permeable to another. Impermeability is often a temporary condition due to inflammatory edema about an organic stricture.

Symptoms and Results of Stricture.—There is usually a history of repeated attacks of urethritis. A chronic discharge may exist, the amount of which is variable. There is a feeling of weight in the perineum, soreness of the back, and frequency of micturition. Hypochondriacal tendencies are usual. In a deep stricture there is difficulty in starting the stream in micturition. In most cases the stream is small, twisted, and forked. There is often interruption or "stammering" of the stream, and it dribbles long after the conclusion of the act, so that the penis must be "milked" before it is returned within the clothing. The urethra back of the stricture dilates, a pouch forms, drops of urine collect and decompose, and a chronic inflammation results in the mucous membrane or the parts adjacent, which inflammation may go on to ulceration or to peri-urethral abscess. A urinary fistula results from the opening externally of a peri-urethral abscess. Retention of urine may occur, not from actual obliteration of the tube by the growth of the stricture, but by closure of the lumen of the urethra by muscular spasm and by edematous swelling in the neighborhood of the stricture. Edematous swelling may be due to cold, wet, venereal excitement, the use of alcohol, overexertion, etc. Spasm of the muscles results, and contact of the urine increases the spasm, and spasm plus edema of the mucous membrane closes the urethra. Spasm may exist in the urethra itself and in the muscles of the

neck of the bladder, but is only a temporar the bladder is hypertrophied and often fasc cystitis. The diagnosis of stricture and of i

> of exploratory bougies. follows to a great extenwhich is as follows: \* H two glasses. Examine the uri in the first glass shows that ureth charge exists. Cloudiness in the secon points to cystitis. The patient is pla cumbent with his shoulders elevated. urethra is washed out with warm salt : or boracic acid. Bulbous sounds are i beginning with No. 15 French. If thi with ease, take a larger size and note strictures are situated by the catch of drawal. If No. 15 does not pass. smaller size. Remember that the p layer of the triangular ligament ca bulbous instrument on withdrawal. meatus is too small to permit of expl divide it with a curved bistoury, cutting within outward. After cutting the bleeding is arrested with styptic cott a piece of absorbent cotton is tuck the cut. After each act of micturit patient inserts a fresh bit of cotton, a three days the urethral examination ceeded with.

Treatment.—A stricture of large in the deep urethra requires gradual tion. A steel bougie is introduced fifth day, the size being gradually ind Never anoint a bougie with cosmoli may become a nucleus for a stone bladder; use oil, glycerin, synol se lubrichondrin. Before passing an —Syme's ment the patient urinates and his is washed out with salt solution or acid solution. Glans, meatus, and ure

cleansed as directed on page 1338. The sound dered sterile by boiling before using. Gradual tion can be effected by the use of the dilator o lander, the tube being distended to the extent millimeters every fifth day. If after dilatatio is urethral spasm, pain, or very frequent mich for a number of days and order each night a h

\* Med. Record, Nov. 14.

goric. In effecting gradual dilatation by sounds the instrument should be introduced every fifth day. During the treatment the patient should not use alcohol,

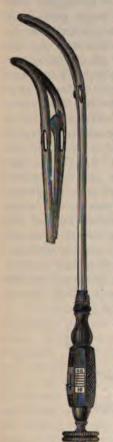


Fig. 811. -Gross's urethral dilator.

should refrain from sexual excitement, should avoid cold and damp, and should take internally capsules containing boric acid and salol. It is rarely necessary to dilate above No. 32 French. After the surgeon finishes treatment he teaches the patient to use an instrument and directs him to pass it once a month. Strictures in the pendulous urethra, if soft, are treated by gradual dilatation; if fibrous and contractile, by internal urethrotomy. In performing internal urethrotomy prepare the patient carefully; for several days before the operation give salol

and boric acid by the mouth, and wash out the bladder repeatedly with boric-acid solution. Be thoroughly aseptic. Anesthetize the patient. Before cutting irrigate the urethra with warm normal salt solution, and after cutting irrigate again and tie in a rubber catheter. These precautions will prevent urethral fever. In cutting, insert Gross's urethrotome (Fig 812) back of the stricture, spring out the blade, cut the stricture on the roof of the urethra, close the blade, withdraw the instrument, and pass a full-sized bougie.

Stricture of the meatus requires incision with a knife and the use of a meatus bougie until healing is complete. Strictures of small caliber in front of the membranous urethra require gradual dilatation and, if this fails, internal urethrotomy or divulsion. Internal urethrotomy can be performed with the urethrotome of Maisonneuve (Fig. 810). This instrument is shaped like a sound, has a groove upon its surface, and into this groove a shaft carrying a triangular knife

can be inserted. The staff is screwed to a guide, the guide is carried into the bladder and the staff follows it. The point of the staff is carried to the prostatic urethra and the guide curls up in the bladder. The penis is held upon the stretch, the blade is inserted and pushed down through the stricture. This instrument cuts the stricture, but not the healthy urethra. For divulsion the patient is prepared as for internal urethrotomy. The divulsor of Gross, or of Sir Henry Thompson, or of Gouley (Figs. 811, 813, 814) is introduced, the blades are separated, the



instrument is withdrawn, a large bougie is passed, and a catheter is tied in the bladder. Strictures of small caliber in the deep urethra require gradual dilatation; if this fails, employ external urethrotomy. In strictures of the deep urethra, if only a filiform bougie can be in-

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troduced, the bougie may be left in place, a can be slipped in beside it, until in a few permeable to a metal bougie. A tunnelled the filiform bougie, both be withdrawn, and tunnelled and grooved staff can be carried in urethrotomy be performed. Thompson's dila filiform and the stricture be divulsed. Fort's to be of value, but I have had no personal e



Fig. 813.-Thompson's divulsor.

pole of a galvanic battery and the positive p The guide carrying the blade is inserted the blade comes against the stricture the c platinum passes rapidly through the constrict off and the instrument is carried onward un when the current is again turned on, and so strength is 10 to 15 ma. The operation requir causes but little pain. After its performance



Fig. 814-Gouley's divu

of the French scale). The patient need not operation. By Fort's method we act purely impassable stricture of the deep urethra perform without a guide (the operation of Wheelhouse)

If a perineal fistula exists, dilate, divulse, catheter in the bladder for forty-eight hours. few days with a metal instrument. Every nurine with a soft catheter, introduce boric-a remove the catheter, and let the man empty his will flow from the fistula and a part from the nutity which comes from the fistula lessens, and heals.

Urethral Fever.—Any operation upon by a chill owing to shock (urethral shock), a nervous fever. Urethral fever proper is s operation. This condition is due to absorp may be in the urine, may have been in the urethra, or may have been introduced from without. It usually follows the first urinary act after operation. It begins with a violent chill and presents the characteristics of a septic fever. It is accompanied by a marked tendency to urinary suppression, and may eventuate in septicemia or pyemia. Urethral fever can be prevented by rigid antisepsis. If this fever should arise, a catheter must be tied in the bladder, the bladder and urethra must be repeatedly irrigated with aseptic or antiseptic fluids, and the patient must be given urinary antiseptics and stimulants by the mouth.

Urinary Fever.—Sir Benjamin Brodie pointed out that the withdrawal of residual urine in a case of enlarged prostate may be followed by very serious symptoms. The condition is spoken of as urinary fever, and is said by many to be due to the sudden and complete emptying of a bladder which has become accustomed to retaining permanently a considerable quantity of urine. Modern studies prove that urinary fever is due to infection of the bladder and kidneys, and not simply to the sudden withdrawal of all of the urine from the bladder, although such a procedure leads to vesical congestion and probably favors infection. The bacteria most often found are pyogenic cocci, colon bacilli, and micro-organisms which cause putrefaction and decomposition of urea.

The condition does not arise promptly, suddenly, and violently, as does urethral fever, but begins rather insidiously after several days. Mr. C. Mansell Moullin thus describes the condition: \*

"So far as the broader features are concerned, the symptoms that present themselves in these cases are remarkably uniform. They do not begin at once. Nearly always some few days elapse before there is anything to excite suspicion. Then the urine becomes cloudy, though it may still retain its acid reaction. A small quantity of albumin, more than can be accounted for by the amount of pus that is present, makes its appearance. Under the microscope there are a few hyaline casts, perhaps a blood-corpuscle or two, numerous pus-corpuscles, and myriads of bacteria. The specific gravity is lower than it ought to be, and is lower than it was before the catheter was used. The total amount passed in the twenty-four hours may either increase until it is as much as seven or eight pints, or diminish until it scarcely reaches twenty ounces. There is seldom any definite rigor, but there may be numerous slight chills. The pulse grows more rapid and feeble. tongue becomes red and dry. There is complete anorexia. Delirium sets in at night, and in a considerable proportion of cases the symptoms rapidly grow worse and worse until, at the end of a few days, the patient sinks into a semi-comatose condition from which he seldom rallies. there are all the signs of recent acute cystitis and pyelonephritis. The mucous membrane lining the pelvis and calices of the kidneys, the ureters, and the bladder is swollen and stained by old and recent hemorrhages, and here and there a thin layer of pus is adherent to it. The pelvis and the ureters are dilated, the apices of the pyramids are eaten away, the cortex is shrunken and hard, the capsule is adherent, and in places between the tubules are minute collections of pus differing in shape and outline according to the anatomical arrangement."

<sup>\*</sup> Lancet, Sept. 10, 1898.

Treatment.—Aseptic catheterization is urinary fever; and as the urethra contains so the prepuce, glans, and meatus should be wa irrigated with boric-acid or permanganate curethra be irrigated with boric-acid solution before the sterile catheter is introduced to draw

If urinary fever arises, it may be possible gating the bladder with warm normal salt silver (1:8000), or boric-acid solution, and diuretics, diaphoretics, saline cathartics, and reperform suprapubic cystotomy for drainage.



Fig. 815.-Wheelhouse's

Perineal section is external perineal methods—the operation of Syme, of Wheelho

Syme's Operation.—This operation is contractile, if dilatation fails to cure, or if u ably causes pronounced urethral fever. The staff (Fig. 809) is introduced, and the surgeon line of the perineum and exposes the staff instrument. The knife is carried along the gA catheter is passed into the bladder from several days, and the wound is dressed antis removed it must be used every six hours un the meatus. During the rest of the patient's be passed at regular intervals.



Fig. 816.—Teale's probe

Wheelhouse's Operation.—This operat ment of impermeable stricture. Wheelhouse's until it blocks on the stricture. The periner and in front of the stricture. The edges of with forceps, the surgeon seeks for the opening a fine probe through it, divides the stricture, of wound an instrument known as a probe go furnish a solid floor to facilitate the introduction in place a metal catheter is carried from the gorget is removed and the catheter is tied in placeatheter is removed and is then passed frequently.

of course, dressed antiseptically. Figs. 815 and 816 show the instruments for Wheelhouse's operation.

Cock's Operation.—This operation opens the urethra back of the stricture and without a guide and relieves retention of urine. The surgeon introduces into the rectum the index-finger of the left hand, and the tip of the finger is rested upon the apex of the prostate gland. The surgeon incises the median line of the perineum, the back of the knife being toward the anus. When the point of the knife is felt to be near the finger the handle is lowered slightly, the blade is placed a little oblique, and the urethra is opened. A catheter is passed into the bladder from the wound and retained for a time, and the stricture is subsequently treated.

Epispadias is a congenital cleft in the corpora cavernosa, the roof of

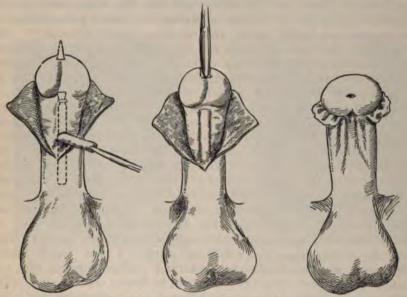


Fig. 817.-Beck's operation for hypospadias.

the urethra being completely or partly absent. In complete epispadias there are absence of the pubic arch and exstrophy of the bladder.

Partial epispadias may sometimes be remedied by a plastic operation.

Hypospadias is a congenital cleft on the floor of the urethra, the meatus opening on the floor at some point between the scrotum and the end of the glans penis, the channel in front of the meatus being a gutter and not a tube.

Hypospadias of the glans is the most common form. In this condition the urethra has no floor, as it passes beneath the glans, the site of the urethra is indicated by a groove, and the foreskin is absent below. Partial hypospadias requires no treatment except possibly dilatation or incision of the meatus. People who suffer from it are very prone to develop chronic urethral inflammation. In hypospadias of the penis the ill-developed cord-like corpus spongiosum draws the penis to the scrotum. In this variety of the deformity the penis is very short.

In complete hypospadias the opening of the urethra is back of the scrotum in the perineum, the penis is dwarfed and bound down, and looks not unlike a clitoris, the scrotum is divided into two portions, a gap existing between them, and in many cases the testicles have not descended. Such individuals are occasionally mistaken for females. In the penile complete forms of hypospadias a plastic operation should be performed between the eighth and tenth years of age. Such an operation unfortunately may fail. Hypospadias is rare in women, but it may occur. In such a case the urethra opens into the vagina. Fig. 817 shows the ingenious operation successfully practised

by Carl Beck for penile hypospadias.

Chancroid (soft chancre; the local venereal sore) is an ulcer, usually of venereal origin. The name chancroid was introduced by Clerc, who believed that a soft sore resulted from inoculating a person already syphilitic with the products of a hard sore. He further held that when a soft sore arose the syphilitic poison lost its infective properties, and "could be transmitted as a soft sore to a healthy person, and not cause general infection." \* The chancroidal ulcer is not connected with the syphilitic poison, but is developed by inoculation with the bacterium of Ducrey. Until recently it was believed that a chancroid was not produced by a special poison, but arose after inoculation with inflammatory products or irritating secretions. It seems to have been proved, however, by Krefting and Colombini that the organism discovered by Ducrey in 1880 is the real cause. This organism is grown on a medium of fresh blood and bouillon or in "unmixed human blood." (See Lincoln Davis, "Observations on the Distribution and Culture of the Chancroid Bacillus." Report of Research Work, 1902-1903; the Division of Surgery of the Medical School of Harvard University.) As a rule, chancroids are of venereal origin, and result from contact with other chancroids, pus, mucopus, or areas of ulceration. A chancroid appears soon after intercourse, usually within five days, always within ten days. It is first manifested by a pustule which ruptures and discloses an ulcer. This ulcer has sharply defined and undermined margins; it looks "punched out"; the base is gray and sloughy; the discharge is profuse, purulent, foul, and auto-inoculable, and causes fresh chancroids by flowing over the parts. The area around a chancroid is red and inflamed, and considerable pain is apt to be complained of. The original chancroid spreads and new sores appear. The edge of a chancroid is rarely indurated unless caustics have been used or there is mixed infection with syphilis. Inflammatory induration fades gradually into the tissues, but the induration of a hard chancre is sharply defined. Fournier says that a chancroid may have a hard base if the sore is located in the sulcus back of the glans, on a lip of the meatus, or on the lower border of the prepuce of a man with phimosis, or when the ulcer is inflamed. The surgeon should always ask if the sore has been cauterized and how !! has been treated. When a chancroid after a time displays marked and sharply outlined induration it points to mixed infection of chancroid and syphilis. Chancroids are not followed by constitutional symptoms, but are apt to be accompanied by painful inflammatory buboes which are prone to suppurate. In hospital practice about 30 per cent, of patients develop but boes. The bubo may be one-sided or bilateral. The adenitis of chance \* "Syphilis," by Alfred Cooper.

is due in the majority of cases to the absorption of toxins and pus may be free from bacteria. Cases have been reported in which non-indurated sores were followed by syphilis. It is probable that a mixed infection existed, and that induration was overlooked, because a papular initial lesion was underneath the chancroidal ulcer. When inflammation in chancroids is high, a rapidly destructive ulceration known as *phagedena* may arise (Figs. 818 and 819), but this process is more common in syphilitic sores.

Treatment.—Ordinary cases of chancroid are treated by spraying with peroxid of hydrogen, drying with cotton, touching each sore first with pure carbolic acid and then with pure nitric acid, and dressing with black wash or dusting with iodoform or with calomel. Every few hours the patient soaks the penis in hot salt water (a teaspoonful of salt to a pint of water), sprays the sores with peroxid of hydrogen, dries with cotton, and dresses with black wash or dusts with iodoform or with calomel. As soon as granulation begins the sores should be dressed with 1 part of ointment of nitrate of mer-



Fig. 818.—Buttonhole perforation of the prepuce following phagedenic chancroid (Horwitz).



Fig. 819.—Buttonhole perforation of the prepuce following phagedenic chancroid (Horwitz).

cury to 7 parts of cosmolin. Mild cases do well without cauterizing, peroxid of hydrogen being frequently used and a drying powder being employed. In chancroids with phimosis slit up the foreskin, smear the raw edges of the wound with pure carbolic acid, and treat the ulcers by cauterization. A regular circumcision often fails because of infection of the stitch-holes. Phagedena requires the internal use of iron, quinin, and milk-punch, and the local use of powerful caustics (bromin or nitric acid or even the actual cautery). In some cases continuous antiseptic irrigation is valuable. When a bubo first begins, order rest, apply iodin or an ointment of belladonna or ichthyol, and make pressure by a spica bandage of the groin. Some surgeons advise the injection of 20–40 minims of a solution of carbolic acid (gr. x to the ounce), but I have never seen any benefit from it. Some inject a 1 per cent. solution of bichlorid of mercury, but the proceeding causes intense pain. Welander recommends the injection of a 1 per cent. solution of benzoate of mercury. I have had no experience with this method. If the

bubo persists, even though it does not suppu excised. If pus forms, several methods of tre ration, injection with a solution of carbolic aci injecting 10 per cent. ointment of iodoform opening with collodion (Scott Helms). Hayde out the pus, washes out the cavity with peroxid gen, and then with corrosive sublimate solution warm iodoform ointment, and dresses with co corrosive sublimate gauze to set the ointme Fontain, Perry, and others commend this plan. sometimes found it to succeed. If the above-r plan fails, if it is not used, or if an ulcer or sin incise, curet, cauterize with pure carbolic acid, hopelessly infiltrated skin, and pack the wor iodoform gauze. In some cases it will be nece gland.

Phimosis is a condition of the prepuce the glans impossible. It is usually congenital, but tion. Congenital phimosis causes retention of composes and lights up inflammation and the the glans. Congenital phimosis may induce continence of urine, prolapse of the rectum, as The treatment is circumcision. Asepticize the



Fig. 821.-Cancer of penis (Horwitz).

sionally during coition. The treatment consi arrest bleeding, and occasionally incisions to le Gangrene of the penis arises from phag bands around the organ, from fracture with exparaphimosis. If extensive, it requires amputa

Cancer of the penis (Fig. 821) is common In a limited epithelioma of the foreskin circum glands of the groin are removed; if cancer affects the glans, amputation of

the penis and removal of the inguinal glands must be done.

Amputation of the Penis.—Ricord advised cutting off the organ with a single stroke of the knife, making four slits in the mucous membrane of the urethra, and stitching each of these flaps to the skin. Treves splits the skin of the scrotum along the raphé, separates the halves of the scrotum down to the corpus spongiosum, passes a metal catheter down to the triangular ligament, inserts a knife between the corpus spongiosum and the corpora cavernosa, withdraws the catheter, cuts the urethra across, detaches the urethra from the penis back to the triangular ligament, cuts around the root of the penis, divides the suspensory ligament, detaches each crus from the pubes, slits up the corpus spongiosum half an inch, stitches its edges to the rear end of the scrotal incision, introduces a drainage-tube, ligates the vessels, and sutures the wound.

Seminal Vesiculitis.—Inflammation of the seminal vesicles is due to the extension of a gonorrheal inflammation, to a pyogenic process, or to

tuberculosis.

Acute inflammation is made evident by frequent and painful micturition, pains in the anus, rectum, and perineum, and possibly the hip-joint, back, and thigh. Defecation and micturition are excessively painful. Persistent erections may take place, and in some cases bloody ejaculations occur. Rectal examination detects the enlarged and tender vesicles external to the lateral lobes of the prostate and on a higher level.

Treatment.—Abandon local urethral treatment, and treat the patient as

for acute prostatitis.

Chronic vesiculitis may result from the acute form or may develop insidiously in an individual with gonorrhea. It is one of the causes of chronic urethral discharge. The patient suffers from imperative and frequent demands to micturate, and he has a gleety discharge which becomes worse and better, but does not disappear. This chronic inflammation is believed to persist because of narrowing of the duct and consequent incomplete drainage of the vesicle. In chronic seminal vesiculitis there is usually sexual weakness,

nocturnal emissions occur, and the semen may contain blood.

Treatment.—Treat the posterior urethritis by ordinary methods. Use hot rectal enemata. Milk the ducts by Fuller's method once every seven days. During massage the patient's bladder should be full. He leans over a chair-back, the knees being straight and the body at a right angle to the thighs. The surgeon covers his finger with a rubber stall and anoints it with oil or synol soap, and introduces it into the rectum, and makes pressure over the pubes with the fist of the other hand. The finger comes in contact with the lower half of the vesicle; it makes firm pressure for a moment, and is then drawn slowly toward the duct. This stroking is repeated several times. The other vesicle is treated in the same manner. This maneuver empties the vesicle and hastens the resolution of inflammation. After the completion of the stripping the patient should micturate, and the bladder and urethra should be irrigated.

Tuberculosis of the Seminal Vesicles.—Primary tuberculosis is very unusual. As a rule, there is antecedent tuberculosis of the testicle or prostate gland. About 50 per cent. of the cases occur in individuals under

forty years of age. The diseased vesicle is but later undergoes caseation and softening through the capsule and invades adjacent a cases and found that in 34 of them the lungs

Tuberculous vesiculitis may be unilate tuberculous epididymitis the corresponding v In bilateral disease of the testicles both ver Peritoneal tuberculosis may follow tuberculo cases spontaneous cure is obtained by fibro tion a tuberculous vesicle is found to contaslightly tender nodules.

Treatment.—If tuberculous epididymi vesiculitis, it is justifiable to remove the ticle, provided the prostate and other parts free from disease and there is no distant testicles are removed, both vesicles can be vesicles suffer from primary tuberculosis, or geons. Reported cases, however, do not see

Kraske, Schede, and Rydygier have remo resection of the sacrum. Zuckerkandl, Dit the perineal route. Villeneuve reached then The curved perineal incision of Zuckerkandl H. H. Young makes a suprapubic incision, bladder, and reaches the vesicles from behi retrocystic-extraperitoneal method (H. H. Y. Nov., 1901).

Acute Prostatitis.—Acute inflammat be caused by inflammation in adjacent struirritant applications in the deep urethra, it calculus, various infectious diseases, a strictur by gonorrhea. The gland enlarges greatly, with blood and pus, and the gland-ducts distinct abscess may form. The orifices of distended and filled with pus, and the sem also suffer. An abscess is liable to form in prostate.

Symptoms.—A feeling of weight, fulnes persistent pain at the neck of the bladder; present and becoming most severe as the tenderness; painful defecation; and bulging a finger is introduced into the rectum, it can enlarged and tender gland, unless the outline in which case there will be felt a large, be Morris on "Injuries and Diseases of the These symptoms are accompanied by dis The inflammation may abate without suppuratemperature becomes characteristic, the pai causes agony, the inflammatory mass is felt per times the swollen perineum becomes dusky re-

certain to occur. The abscess may rupture into the urethra or the rectum, or may diffuse in the periprostatic cellular tissue and subsequently may open in the perineum. Spontaneous evacuation may be followed by recovery or by the development of annoying or dangerous complications.

Treatment.—Keep a hot-water bag on the perineum and three or four times a day use rectal injections of hot water. Place the patient on a milk-diet. Leech the perineum. Give suppositories of opium and belladonna, and also suppositories of ichthyol, and administer urotropin by the mouth. At the first sign of suppuration make a curved perineal incision. Retention of urine is relieved by a soft catheter.

Chronic Prostatitis.—May arise from stricture, venereal excess, chronic cystitis, or stone in the bladder, but gonorrhea is the common cause. The prostate is usually, but not always, enlarged, is somewhat softened, and

the ducts contain pus and blood.

Symptoms.—There is usually a mucopurulent discharge or fluid can be obtained by massage of the prostate. There is a feeling of weight and fulness in the perineum, there is increased frequency of micturition, and the prostate is very sensitive to digital pressure. The patients are neurotic, frequently suffer from nocturnal emissions, and have but feeble power of erection. The prostatic urethra is extremely hyperesthetic. All the symptoms are aggravated by worry, sexual excitement, or violent exercise. An abscess may form and rupture into the urethra.

Treatment.—Tonics and nutritious food are essential. Intravesical irrigations with nitrate of silver solution (1:8000) do good. Massage of the prostate is useful. Some cases are benefited by touching the posterior urethra through a urethroscope tube with nitrate of silver (3 grains to the ounce) or by injecting by means of Ultzman's syringe a few drops of silver nitrate solution (5 grains to the ounce). Rectal suppositories of ichthyol may be ordered. Blistering the perineum at intervals may prove of service. At intervals of three or four days a full-sized cold steel sound should be gently introduced. If an abscess forms, open it through the perineum.

Prostatorrhea.—Just as overaction of the glands of the urethra constitutes urethrorrhea, so overaction of the glandular apparatus of the prostate gland constitutes prostatorrhea. Prostatorrhea is not inflammatory, although the prostate and posterior urethra are often congested, and the latter region is usually hyperesthetic. In some cases urethrorrhea exists with prostatorrhea. Prostatorrhea is produced by sexual excess, masturbation, ungratified sexual desire, and riding a bicycle with an improper seat. The condition is usually accompanied by marked neurasthenia, and may be associated with spermatorrhea and impotence.

The patient notices a milky or gray discharge after straining at stool (defecation-spermatorrhea), after violent exercise, sexual excitement, or a bicycle ride. The discharge also gathers in the urethra during sleep. Examination of the discharge shows it to be prostatic fluid, although spermatozoids are sometimes found. It is not purulent and contains amyloid corpuscles. The meatus is not glued up in the morning, and the linen is very slightly stained. The urine is clear and contains small comma-shaped hooks (Christian). Sexual excitement and alcohol do not appreciably aggravate the condition. The bladder is irritable, and there are frequency of micturition and

often some pain in the head of the penis at the turnal emissions may occur.

Treatment.—The patient should correct be hyperesthesia or prostatic congestion, irrigate to day with a solution of silver nitrate (1:4000), introduce a cold sound. In some cases the prostatic urethra of a few drops of a 1 per cerebose good.

For the irritable bladder give hot hip-b prescription is of service: gr. xv of bromid of of hyoscyamus in ½ ounce of cinnamon-water, the

are of service.

After the hyperesthesia of the urethra has a have ceased, the neurasthenia is treated by co and morning, the continued use, at intervals o cold sound, irrigation every second or third da and the administration of strychnin and other

Hypertrophy of the Prostate Glai Morgagni that in old men difficulty of micture an enlarged prostate gland. Enlargement of brought about by different forms of growth, senile change, occurring only after the age of to arise after the attainment of sixty years, of the prostate to cause symptoms long before the age of seventy. Sir Henry Thompson men over sixty have prostatic hypertrophy, by troublesome symptoms. According to Freyer fifty-five years of age present some enlargement.

There are some that oppose the view that tially a senile change. For instance, Dr. L. matol. and Gen.-urin. Dis.," March, 1901) not senile; that it really begins early in life, bu manifest until during or after middle age. during the third decade of life, but does not symptoms till beyond middle life. Socin and postmortem examinations, reached the follow ages of thirty-six and forty the gland is hypertr between forty and fifty in 25 per cent., betw cent., between sixty and seventy in 56 per cen in 50 per cent., between eighty and ninety in 5 enlargement begins long before it occasions symptoms, and the growth progresses very slow school maintain that hypertrophy of the pros of arteriosclerosis, affecting not only the prosttract. The hypertrophy that ensues affects well as the prostate, because of distinct gro demonstrated that Guyon's view is not correct. cases there is no sclerosis of the prostatic arte are no sclerotic changes in other portions of important point made by Caspar is that arteriosclerosis tends to cause degeneration, and not hypertrophy.

Some think that sexual excess is a cause of prostatic enlargement; some assert that antecedent gonorrhea is the cause, but it seems very improbable that either is causal. Belfield blames altered testicular secretion; Hawley believes the cause to be altered prostatic secretion and the "chemical action of pathologic proteids resulting from irregular metabolism or derived from disintegration of the secretion, or in the usual action of tissue enzymes" (G. W. Hawley, in "Annals of Surgery," Nov., 1903).

In the hypertrophied prostate there is an excessive production of fibrous tissue and of ill-formed glandular tissue, the mass constituting a fibro-adenoma. Fibro-adenoma is the common cause of enlargement (W. Bruce Clarke). Typical adenoma, according to Albarran and Hallé, is found in 14 per cent. of the cases ("Ann. des Mal. des Org. Gén.-Urin.," Feb. and March, 1900). Again, in not a few prostates there is no real enlargement, but there is an indurated fibrous mass producing obstruction. Albarran and Hallé ("Annales des Maladies des Organes Génito-Urinaires," 1898, vol. xvi) point out that in an enlargement of the prostate different elements may usually be recognized: soft hypertrophy of the gland; indurated enlargement of the glandular elements; fibrous enlargement; circumscribed tumor-masses; distinct fibromata or myomata; or adenofibromyomata. The real cause of the various forms of prostatic enlargement is not known. Nearly 10 per cent. of cases are cancerous (Oraison), and adenoma is apt to be transformed into cancer.

All the lobes may be enlarged equally; all may be enlarged unequally; the enlarged gland may surround the prostatic urethra like a horse-collar; or one lobe only may be enlarged. Symmetrical enlargement of the entire gland is not so apt to produce symptoms as is a non-symmetrical enlargement. In some cases the chief enlargement is into the bladder; in others, into the urethra. An enlarged prostate frequently shows a circular groove about it, due to the constriction exerted by the rectovesical fascia at the vesical neck.

The bridge of prostate which joins the two lateral lobes behind the urethra is known as the lobe of Home or the "middle lobe," and a comparatively trivial enlargement of the middle lobe may cause obstruction. Prostatic hypertrophy causes a narrowing and lengthening of the urethra, and gives this tube a tortuous course. The opening of the urethra into the bladder is usually pushed to a higher level, and there forms behind it a pouch in which urine collects. The urine that gathers in this pouch is known as residual urine. It cannot be voluntarily expelled. It may, therefore, collect in large quantity, and it is likely to decompose, producing cystitis. Residual urine strongly favors calculus formation. The mechanical resistance to the expelling of the urine causes congestion of the neck of the bladder and the posterior urethra and also hypertrophy of the muscles of the bladder. In consequence of the hypertrophy the bladder enlarges, thickens, and becomes fasciculated. When this takes place, micturition becomes very difficult and sometimes impossible. Enlargement of the middle lobe inevitably blocks the flow of urine and causes great distention of the bladder. In hypertrophy of the prostate gland the ureters and the renal pelves and calyces may distend and surgical kidney may develop.

It is useful to divide, as does Horwitz, persinto three groups: (1) those in whom there is urinary symptoms are very trivial; (2) those in and disturbances of urinary function, who relief, but who do very well by this method; a plete breakdown during the period in which (Orville Horwitz, in "Phila. Med. Jour.," No

Symptoms.—In 90 per cent. of the cases ence, the patient merely being annoyed somewl quency of micturition. The stream of urine from the end of the penis. In some cases the (stammering). The last drops fall entirely becomes chilled or worried, or indulges inorc table or in wine, beer, or alcoholic liquors, noc becomes for a short time most harassing. bladder cannot be emptied entirely, and resid of micturition comes on, particularly at night; the bladder never feels empty; and cystitis is acid and clear, becomes neutral and cloudy turbid, and contains bacteria, mucopus, pr blood. Above the pubes there is aching pa neum, which pain is increased when the bl micturition. The rectum becomes irritable, the mucous membrane occurs, because of str of retention of urine may occur. In about ona diagnosis by rectal palpation. In enlarge or in pure intravesical enlargement rectal to nosis and the cystoscope must be relied upon and distended, or hypertrophied, rigid, and fa incontinence is caused by the median lobe g bladder and preventing closure. The health restless nights, indigestion, and disorder of become involved (inflammation of the pelves and suppression may occur. Septic fever may the bladder. Death is due to exhaustion, cystitis. A foul catheter is the usual cause organisms sometimes enter by passing along t

A patient should be examined by rectal tou scope, if possible; the amount of residual urin condition of the urine is carefully studied. stone should always be determined. After a the patient must remain in bed for twenty-four

Treatment.—There is no known method trophy. Many cases of enlargement are treated if this is conducted with careful cleanliness, i hygienic rules, he may be kept comfortable for has formulated several sound rules as to whe treatment. He says, if the patient is intelligen severe, if the amount of residual urine is not

great, if the bladder retains considerable expulsive power, and if catheterization is easy and painless, we are justified in relying upon this simple plan of treatment. Prevent cystitis by emptying the bladder each evening with a coudé catheter. If there is trouble in passing the catheter, strengthen the instrument by inserting a filiform bougie as a stylet (Brinton). It is very seldom that a metal instrument is used, but if it is required, a catheter with a large curve is employed. If a soft semisolid instrument can be passed, teach the patient how to clean it, how to use it, and how to keep it, but never permit the patient to use a metal instrument himself. A dirty instrument may cause fatal infection. It is true that some people use dirty instruments for long periods without trouble, but in most cases there will be trouble if it is attempted. It is absolutely necessary to use only perfectly aseptic instruments. Metal instruments are sterilized by boiling in water. Rubber catheters can be cleansed by washing with soap and running water and boiling. Woven instruments can be placed in a glass cylinder, the bottom of which is like a sieve. This jar is placed for twenty-four hours in a vessel which contains formalin. The vapor of formalin is an excellent germicide, and does not injure the catheter. After sterilization the instruments are kept ready for use in a glass cylinder which contains calcium chlorid.\* Guyon scrubs the catheters with soap and water, dries them outside and inside, and places them in a sealed jar, and exposes them to the vapor of sulphurous acid for forty-eight hours. If there are three ounces of residual urine, use the catheter only at night. If there are six ounces, use it night and morning. If there are more than six ounces of residual urine, add one more catheterization a day for every additional two ounces present until the catheter is used six times in the twenty-four hours. It should never be used oftener than this. Gradual dilatation with steel sounds is of benefit, but forcible dilatation is not advisable. The sound may be passed once a week. Tell the patient to avoid violent exercise, cold, damp, sexual excitement, and the use of alcoholic liquors; prevent constipation and indigestion, and direct him to drink milk and plenty of water. A hot hip-bath at night adds to his comfort. Hot enemata are of value. If a large quantity of residual urine exists, or if cystitis begins, wash out the bladder daily with boric-acid solution, or normal salt solution, or nitrate of silver (from 1:10,000 to 1:2000), and give urotropin or salol and boric acid by the mouth (Cystitis, page 1319). In some severe cases, if a large-sized rubber catheter be tied in the bladder for a few days, great relief is obtained. Retention of urine can be relieved by the introduction of a coudé catheter strengthened with a whalebone. In exceptional cases a silver instrument with a prostatic curve must be employed or aspiration must be practised. Many cases occurring among well-to-do people can be kept comfortable by catheterization. Some surgeons still think that only when this fails should an operation be performed. Unfortunately, sooner or later the regular use of the catheter will cause cystitis. A poor man cannot give the necessary time and attention to make catheter life safe and operation must be thought of in him sooner than in others. If the symptoms grow constantly worse, if the suffering becomes severe, if the patient cannot urinate without the use of an instrument, if catheterization is painful or impossible, if the patient is too careless or ignorant to trust with a catheter, if only a catheter of very

<sup>\*</sup>R. W. Frank, in Berliner klin. Woch., No. 44, 1895.

small size can be introduced, if attacks of o persistent or recurring cystitis or hematuria, fection of the kidney, if the residual urine bladder should be opened. Do not post becomes really ill. Give palliative measur fail, operate. Before determining upon a examination. This is particularly valuable before a perineal operation. It shows us nature, size, and situation of the enlargen and a calculus if one exists. This exam of operation desirable. Prostatectomy is affair certain to result in cure. It is a gra mortality, which may be attended by di which unfortunate consequences may arise that-"It is altogether too grave an operat treatment for every enlarged prostate, an selected cases." The operation is contr disease of the kidneys, and if it is perform to be expected. Age is not in itself a co cardiovascular system are sound. An occ incontinence of urine due to injury of the ne of the part. A usual sequel is impotence.

In the majority of cases in which pallia is to remove an obstructing mass and depr the bladder into the prostatic urethra, abolished and the bladder can be thorough between prostatotomy and prostatectomy. by the galvanocautery (Bottini's operation) pubic or perineal, and the latter may be sight (as in the operations of Nicoll and (as in Young's operation). No one routing The patient should be studied and the ope best for that individual case. The surgeon wrong many patients, and he retains consis It was formerly believed that any operatio necessity produce impotence. This we now suprapubic operation is probably less likely perineal, as it usually spares the ejaculatory tion spares the ejaculatory ducts. Destr certainly produces sterility and may, but do tence. Willy Meyer ("Med. Record," Oct. may also be caused by damaging important cing through the perineum, and also by the the verumontanum and prostatic urethra, erection.

The perineal operation is as safe as the rapidly performed. It is the desirable route per rectum and does not mount high up wh stages of soft hypertrophy (Willy Meyer, in and when prolonged drainage is required. According to Francis S. Watson ("Annals of Surgery," June, 1904), the mortality in 203 cases was only 2.9 per cent. In 563 cases of removal through the perineum by dissection, the mortality was 5.5 per cent. Young's cases in this group number 150 and his mortality was 4.6 per cent., the mortality of Hartman's was 9 per cent., of Albarran, 4 per cent., and of Murphy, 3.9 per cent. (Schachner, in "Annals of Surgery," August, 1908). In 190 cases of blind enucleation through the perineum the mortality was 4.7 per cent. (Schachner, Ibid.).

After the performance of the perineal operation the drainage is at the lowest part of the bladder. In a perineal operation every effort should be made to do as little damage as possible to the urethra. If we destroy the entire prostatic urethra, the operation becomes easy and rapid and nature rapidly repairs it, but a traumatic stricture may follow and may make the patient's condition worse than at first. As Moore says, we must destroy a portion of the floor of the urethra, but we can preserve the roof and the side walls. Another point in the perineal operation is to avoid injuring the rectum. A tear may enter the rectum, or, even if the gut was not torn, sloughing of the rectum resulting in recto-urethral fistula may occur. The rectum may be opened because the surgeon fails to stick close to the urethra in his dissection, and sloughing may be due to an injudicious use of the retractors. If the rectum is opened, it should be at once sutured with catgut. In most cases it takes about three weeks for the wound in the perineum to heal, and in some few cases a perineal urinary fistula is established. Urinary incontinence may follow this operation. By simply incising the prostate gland the floor of the urethra may be lowered to the level of the floor of the bladder. Simple incision of the prostate in this manner, or by Bottini's method, is known as prostatotomy. The mortality is small and the relief is often great. Prostatotomy is performed on old and exhausted patients with damaged kidneys. A large tube should be worn during the healing of the wound.

The suprapubic operation is easier than the perineal; it is less safe; it gives excellent results if temporary drainage only is needed. According to Watson ("Annals of Surgery," June, 1904), the mortality in 69 cases was 8.6 per cent. Freyer reports 600 cases varying in age from forty-eight to eighty-nine years. There were 47 between the ages of eighty and eighty-nine, and 7 were seventy-nine; most of the cases had been entirely dependent on the catheter for periods up to twenty-four years. "Nearly all were in broken health and many apparently dying before operation." "Few were free from one or more grave complications, such as cystitis, stone in the bladder, pyelitis, kidney disease, diabetes, heart disease, chronic bronchitis, paralysis, hernia; and in a few instances there was malignant disease of some other organ than the prostate" (P. J. Freyer, in "Archives Internationales de Chirurgie," vol. iv, Fascic, 4, 1909). In these 600 cases there were 37 deaths in periods from six hours to thirty-seven days after operation, a mortality of 6.15 per cent. It is indicated in rather young subjects in whom we greatly fear impotence; in cases in which the gland is placed high; in cases in which the gland is not palpable per rectum, but is causing serious symptoms, and in which the hypertrophy is recognized by the cystoscope (Meyer), this condition exists if there is a middle lobe; in cases in which cancer exists; or in which calculus complicates the case. It is the most useful operation when the hypertrophy is very large

and intravesical. It is not a suitable method tracted or if the belly-walls are very thick. If as it is sure to be in cases with advanced cysti in the perineal operation. If when a suprapub it is found that prolonged drainage is indica is used. If permanent drainage is required in is the best. After a suprapubic cystotomy ha the opening may be kept permanently patent by McGuire's operation). It is only in very ad permanent suprapubic drainage is employed incision the floor of the urethra cannot be bro bladder by a simple incision of the prostate brought level only by the performance of pro operation the strictures divided are less imp and the drainage is better than in the perineal tectomy inflicts injury upon the bladder, it ma of the bladder, and is often followed by in: Murphy, "Jour. Amer. Med. Assoc.," Marc control is less common than after the perinea may be seriously torn, and if such a wound si sutured with catgut. In this operation, if surgeon must exercise great care to avoid ureters may be damaged and subsequently be tion. If death occurs after prostatectomy it is postoperative complications, usually pulmonar gery," August, 1908) uses Watson's figures to each operation. The table is as follows:

	Per cent	
Bottini	- 2.7 . 35.0 . 34.0	Uren
Bottini	. 52.0 . 17.8 . 8.6	Sepsi
Bottini	. 5.0 - 21.4 - 30.0	Shoc
Bottini	. 8.0° . 17.8° . 22.0°	Poste

Freyer's Method of Suprapubic Prowashed out through a catheter with warm be filled with the solution. The nozzle of a lainserted into the end of the catheter. This running out and enables the surgeon to quic occasion shall arise. The bladder is opened free from veins. The incision is vertical, is m is about 1 inch in length (it can be enlarged la are found they are at once removed. A finger up the prostate and keep it steady. The finger

into the bladder, and by means of the finger nail the mucous membrane is scratched through over "the most prominent portion of one lateral lobe, or over the so-called middle lobe, if there be but one prominence" (Freyer, in "Archiv. Internat. de Chir." Fascic. 4, 1909). This portion of the gland is only covered with mucous membrane, and when this is scratched through, the true prostatic capsule is reached. The finger is kept in close contact with the true capsule and enucleates the gland by passing first posterior, next outside, and finally in front of one lateral lobe.

"The finger is then swept in a circular fashion from without inward, in front of and to the inner side of the lobe, detaching this from the urethra, which is felt covering the catheter, and pushed forward toward the symphysis between the lateral lobes, which will, as a rule, have separated along their anterior commissure in the course of the manipulations. The other lobe is attacked and treated in the same manner. The finger is next pushed well downward behind the prostate and the inferior surface of the gland is peeled off the triangular ligament. When the prostate is felt free within its sheath and separated from the urethra, with the finger in the rectum, aided by that in the bladder, it is pushed into the bladder through the opening in the mucous membrane, which, during the manipulations, will have become considerably enlarged" (Freyer, Ibid.). The prostate is removed from the bladder by forceps. If the lobes come away separately, Freyer believes that the ejaculatory ducts are uninjured and remain attached to the urethra. There has been an active controversy as to whether Freyer's operation does or does not destroy the prostatic urethra. It seems certain that even if it is left it must slough for want of blood-supply. In my operations by this method it has come away with the prostate.

In Freyer's earlier operations he sought to leave the urethra and accompanying structures behind, but he is now convinced that the prostatic urethra may be torn or removed without ill results.

McGill's Operation: The bladder is opened by a suprapubic incision, the edges of the cut bladder are sutured to the abdominal wound with catgut, and the interior of the viscus is carefully explored with the finger and by sight, an electric light being used for illumination. If a sessile growth exists, the mucous membrane is incised and the growth enucleated with finger or a curet. A pedunculated growth is cut away with sharp-edged forceps. If a mass projects into the bladder, an incision is made to divide it into two portions and each half is enucleated. Hemorrhage is arrested by irrigation with hot salt solution and by compression with gauze pads. In some cases a tampon must be inserted. The bladder is drained for several days or a number of days by a siphon (Fig. 786). As a matter of fact, a dense fibrous prostate cannot be enucleated and can be removed only by scissors or cutting forceps.

Fuller's Operation: Open the bladder above the pubes; have an assistant push the gland up by means of a fist in the perineum. The gland can be lifted by two fingers in the rectum (Guitéras). The surgeon makes a small incision through the mucous membrane over the prostate, enucleates the gland by means of the finger, and drains through an incision in the membranous urethra, as well as through the suprapubic opening.

Belfield's Operation: Belfield performs suprapublic cystotomy, makes a perineal cut to enable the finger to approach the prostate, pushes the prostate up toward the belly, and enucleates it from within the bladder.

Perineal Prostatectomy.—Perineal prostatectomy is less bloody than suprapubic prostatectomy. The sphincter of the bladder is not damaged, the entire prostate can be brought into view and removed, and perfect drainage is obtainable after operation.

Nicoll's Operation: Perform suprapubic cystotomy. Then incise the perineum down to the prostate, split the capsule of the prostate, insert two



1380



Fig. 822

Fig. 823.

Figs. 822 and 823.—Showing double-tube drainage for suprapuble operation. Fig. 822 was taken from an elevation to show the termination of the drainage-tubes. Fig. 823 shows tubes enlarged in separate view.

fingers of the left hand into the bladder, and push the prostate into the perineum so as to bring it within reach. Enucleate the gland from the perineal wound without damaging the mucous membrane of the floor of the bladder.

Alexander's Operation: Alexander makes a suprapubic incision and uses it for the same purpose as does Nicoll, but he also opens the membranous urethra on a grooved staff. After enucleating the gland he inserts a drainage-tube through the incision in the membranous urethra. In a very thin subject it may not be necessary to perform suprapubic cystotomy. Alexander has brought the gland into an accessible position in the perineal wound by suprapubic pressure, and Guitéras has done so by making an incision in the linea alba and inserting two fingers into the prevesical space. Syms advocate opening into the peritoneal cavity, inserting the hand, and pressing the prostate into the perineum without opening the bladder above the pubes.

Bryson's Operation: This is a satisfactory method in some cases. The

duced and a median perineal section is made to open the urethra just in front of the apex of the prostate gland. The knife is pushed back in the groove of the staff sufficiently far to incise the ring at the apex of the prostate; the forefinger is passed into the prostatic urethra and the staff is withdrawn. Then a short tear is made by means of a blunt instrument into the mass of the left lobe and the finger is introduced and enucleates the lobe. The same procedure is carried out on the right lobe, and, finally, if necessary, on the middle lobe. If the middle lobe requires removal, but cannot be reached, a suprapubic cut is made into the cave of Retzius, two fingers are inserted, and the lobe is pushed within reach of the finger below. A large perineal tube is introduced for drainage and bleeding is arrested by packing. Horwitz also introduces a catheter and ties it in place.

Young's Operation: This surgeon frequently operates under spinal anesthesia. He places the patient in an exaggerated lithotomy position and introduces a sound. In thin subjects the incision is in the raphé and is carried close to the anus; in short individuals the incision is an inverted V. He incises the recto-urethralis muscle transversely, exposes the membranous urethra, opens it, and inserts his tractor into the opening in the urethra (Fig. 828). The tractor is turned 180°, the blades are opened, and traction is made. The capsule is incised on each side of the ejaculatory ducts and the gland is removed by blunt dissection, the forceps grasping each lobe during enucleation (Fig. 829). Every effort is made to save the urethra. After removing the lateral lobes the tractor is used to bring a middle lobe, if one exists, into the wound, and it is also enucleated. The bladder is drained for about one week.

Bottini's Galvanocaustic Prostatotomy.—Bottini, of Padua, in 1874 suggested cauterizing the prostate by means of a special instrument. He sought to burn away a portion of the gland in hope that the contraction of the scar would cause the remainder of the gland to shrink. The instrument of Bottini is shaped like a catheter, and carries a platinum blade which is heated by an electric current. Bottini's early instrument was not satisfactory and the operation never became popular until Freudenberg improved the tools

in 1807 (Fig. 824).

Bottini's galvanocaustic operation is performed as follows: The bladder should be emptied, irrigated, and distended with air, and the posterior urethra must be anesthetized by instillation of cocain or eucain. The current is tried to see how many seconds it requires to heat the blade sufficiently. The current is broken, the instrument is introduced, the cooling current is set in motion, and one assistant watches this and nothing else. Turn on the current. Wait the required number of seconds for the blade to become red hot (twelve to fifteen seconds), turn the screw at the handle, and burn a groove in the prostate. A groove should be burned toward the rectum, one to the side, and, if it is thought desirable, one to the opposite side. No groove should be burned toward the pubes. When a groove has been burned, return the blade into its sheath, increasing the current while doing so in order to keep the blade from adhering to the tissue, then shut off the current. After withdrawing the instrument it is not necessary to introduce and retain a catheter. The patient is confined to bed only twenty-four hours, there is rarely bleeding or fever, and the results are good. The scars contract and the gland atrophies. During the period of healing a steel sound should be passed from time to



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time (Bangs). It is alleged that fibrous stri may follow in some cases.\*

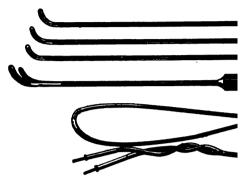


Fig. 824.—Young's modification of Freudenberg's instrui

Bottini's operation is the procedure to be and for hypertrophy in a feeble and aged ir



Fig. 825.—Incisions of the mide

It is not probable that the cautery operation best instrument is Young's modification of

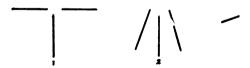


Fig. 826.—Different incisions of prostate gland in

824). Figs. 825 and 826 show various methor by Hugh H. Young. When there is a distinct

\* For description of this operation see Freuden 1897; and Willy Meyer, in Med. Record of March

the ordinary operation fails entirely; but, as Young shows (Figs. 825, 827),

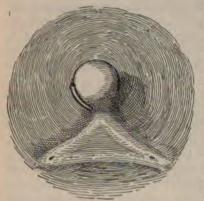


Fig. 827.-Incising the middle lobe (Young).

if an oblique cut is made on each side across the base, this lobe will drop out of the way and quickly atrophy.

Castration and Vasectomy.—In 1886
Sanitzin demonstrated clinically the shrinking of a large prostate after double castration (Hawley, in "Annals of Surgery," Nov., 1903). In 1893 Ramm, of Norway, performed double castration in order to cause shrinking of an enlarged prostate. In 1893, after a long series of careful experiments, J. William White recommended the operation of bilateral orchidectomy for the treatment of prostatic hypertrophy. He proved that removal of the testicles causes a rapid shrinking in an enlarged prostate.

Much of this shrinking may be due to diminution of congestion and edema, but true atrophy undoubtedly occurs in the glandular elements. Very remarkable results have been recorded. In some cases the patients

become absolutely comfortable and dispense entirely with the catheter. Cystitis ceases, and desire to urinate frequently becomes less marked. Unilateral orchidectomy has been employed, but it is not satisfactory. In 1894 Mears suggested ligation of the spermatic cord. In 1805 Lauenstein suggested division of the spermatic cord. In 1896 Tilden Brown suggested ligation of the Reginald Harrison in 1806 advised section of the vas. Lennander in 1897 proposed exsection of the vas deferens (vasectomy). It is slower in its results, but just as certain as castration. In spite of the great simplicity of orchidectomy the mortality has been considerable (from 11 to 18 per cent., according to some authors. Socin and Burckhardt say 16.2 per cent.). In several instances mental disturbance has followed the operation. Castration is now very seldom performed, as vasectomy is just as useful and is safer. Vasectomy is valueless in cases of fibroid

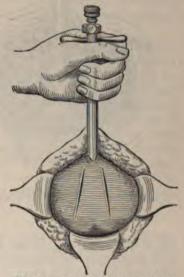


Fig. 828.—Tractor introduced; blades separated; traction made, exposing posterior surface of prostate. Incisions in capsule on each side of ejaculatory ducts (Young).

prostate, does some good in adenoma, but is most valuable when the prostate is generally hypertrophied and prone to great congestion, causing violent symptoms. The testicle does not atrophy after vasectomy, mental disturbance does not occur because the internal secretion of the testicle is still

furnished to the organism, and impotence m must.

Other Methods.—Among other operations of ligation of the vascular elements of the cord ments except the vas and its artery and vein Albarran in 1897); parenchymatous injections ligation of both internal iliac arteries. Angio 5.5 per cent. (Socin and Burckhardt).

Results.—The relative merits of these varies are in dispute. It is certain that many can be kept comfortable by aseptic catheteris for other reasons must be abandoned, or if the sa careful study of the case should be made before. The Bottini operation has come into somewhapply it to almost any sort of case, and claim free from danger. Meyer uses it for any case but if the prostate is very large, ligates the vas cauterizing the prostate, in order to lessen the content of the same cauterizing the prostate, in order to lessen the content of the same cauterizing the prostate, in order to lessen the content of the same cauterizing the prostate, in order to lessen the content of the same cauterizing the prostate, in order to lessen the content of the same cauterizing the prostate, in order to lessen the content of the same can be same can b

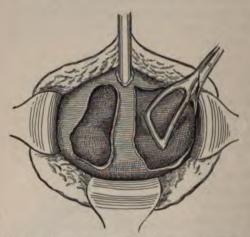


Fig. 829.—Enucleation of lobes. Forceps in position (Young).

ally enlarged prostate. It may do great good urine is extremely foul, some operation permitti adenomatous prostate in which enucleation is extremely foul, some operation permitti adenomatous prostate in which enucleation is extremely access in which it is probal cases of uncertain diagnosis; in cases in which the middle lobe is at fault, do a sometimes a perineal incision may be made, and to bring the floor of the urethra level with the tree.

In old men with great obstruction and wit and involvement of the kidneys, and in individmanent suprapubic drainage is sometimes the The mortality from Bottini's operation is over 5 per cent. Horwitz collected 888 operations: 84.3 per cent. were cured or improved; 10 per cent. were not improved; and 5.7 per cent. died ("Phila. Med. Jour.," Nov. 16, 1901). Young had 3 deaths in 41 operations.

Vasectomy done early gives a mortality of from 3 to 5 per cent. If performed later, the mortality is 10 to 15 per cent. Socin and Burckhardt estimate the mortality of bilateral vasectomy as 8.3 per cent. The mortality of bilateral orchidectomy is 16.2 per cent.

The mortality of prostatectomy is variously estimated. Freudenberg collected 753 cases: 622 were cured, 44 died, and 87 were not improved.

Guitéras collected 152 cases done by various methods ("Jour. Amer. Med. Assoc.," Nov. 2, 1901). Twenty-five died. Bangs believes that the mortality from prostatectomy should not be above 8 per cent., but statistics indicate that it is from 10 to 15 per cent. in most hands. W. Bruce Clarke reports a mortality of 9 per cent. The mortality of the suprapubic operation is higher than that of the perineal operation. Belfield estimates the former at 16 per cent. and the latter at 9 per cent. Watson estimates the mortality of the former as 8.6 per cent, and of the latter as 2.0 per cent.

The earlier the operation is performed, the safer it is. (See "The Choice of Method in Operating Upon the Hypertrophied Prostate," by Willy Meyer, in "Med. Record," Oct. 7, 1905; "A Critical Review of the Technic of Perineal Prostatectomy," by Charles Greene Cumston, in "American Medicine," August, 1906; "The Operative Treatment of the Hypertrophied Prostate," by Francis S. Watson, "Annals of Surgery," June, 1904.)

Malignant Disease of the Prostate Gland.—Primary malignant growths of the prostate are not infrequently encountered, but secondary growths are much more rare than are primary growths. When malignant disease does occur, it is almost always cancerous. Secondary cancer of the prostate finds its most usual antecedent in cancer of the rectum. Epithelioma does not occur. Scirrhus occasionally occurs; but the most frequent form is encephaloid. Round-celled, spindle-celled, or mixed-celled sarcoma may develop. Powers says there have been but 31 authenticated cases of primary sarcoma reported ("Annals of Surgery" Jan., 1908). Sarcoma is most frequent in childhood. It grows rapidly, is usually soft, and causes pain in the rectum and perineum or pubic region, but early in the case, at least, there is seldom residual urine (Powers, in "Annals of Surgery" Jan., 1908). No real cure of sarcoma has yet been reported.

Carcinoma of the prostate may occur at an earlier age than ordinary hypertrophy of the prostate. The latter does not become evident until after the age of fifty; but carcinoma of the prostate may begin at any time after the age of forty, and sarcoma of the prostate may commence in early youth.

At first the carcinomatous growth enlarges slowly; but it soon begins to grow with rapidity. It breaks through the capsule and fungates into the bladder or into the urethra. The pelvic, the inguinal, and the femoral glands become involved early in the course of the disease. It is not usual to find great obstruction to urination or to the passage of a catheter at an early period, but later both these conditions are noted. Early in the case there is pain only when obstruction to urination occurs; later, the pain in the neck of the bladder may be severe, and there may also be pain in the loin and in the sciatic

nerves. Hemorrhage usually occurs. In the trivial and intermittent, but when fungation erally take place. The blood is usually mixed times a large hemorrhage unassociated with likely to contain pus or any large quantity of volved in the growth.

When the prostate gland is felt by means of it is found to be of stony hardness and to be nald Harrison points out that an ordinary hypanchored as a carcinomatous gland; that the dom; and that, although it is firm to the to The patient with carcinoma of the prostate distinct cachexia, and metastatic deposits an column, in the kidneys, and in other organs a

In making a diagnosis Harrison insists u He says that in cancer one does not find m that what projection there is is uneven and in matous prostate, on the contrary, the surfa

projects into the bladder.

Treatment.—Radical operation is out Permanent suprapubic drainage is made in r the patient great relief. (See "Remarks of Reginald Harrison, in "Brit. Med. Jour." of

Tuberculosis of the Prostate Glar tate is rarely primary. It is usually secondary or of the epididymis. In the majority of case the lungs are involved in a tuberculous present by the surgeon. The disease appears twenty and thirty years, but it may attack. It begins by the formation of a number of the diate neighborhood of the prostatic tubules. together, forming cavities and, eventually, the prone to rupture into the urethra. In very lous abscess ruptures through the perineum peritoneum.

The disease occasionally undergoes spot tissue formation or calcification. The tuber to the seminal vesicles, the bladder, the urete and in some cases it inaugurates thrombophle

Symptoms.—The patient suffers with p frequent micturition; and from time to time the of cystitis take place, and weakness and a loss mensurate with any ordinary inflammation alone is said not to cause marked hectic fever become involved, the temperature attains a teristic. When the disease has advanced, the continence, on account of the involvement about the neck of the bladder. Commonly, the or mucopurulent matter may be obtained by

matter may contain tubercle bacilli, and in some cases the urine also contains these bacilli. Early in the course of the case rectal examination detects some enlargement of the gland, many nodules, and tenderness; later in the disease it finds marked enlargement and areas of softening.

Treatment.—Early in the case Senn recommends parenchymatous injections of iodoform emulsion, the punctures being made through the perineum. If these fail, operation must be considered. When one takes into account how rare primary tuberculosis of the prostate is, one is impressed with the infrequency with which a radical operation should be attempted. If there is absolutely no evidence that any adjacent organ is involved or that any distant focus of disease exists, it is justifiable to perform perineal prostatectomy. As a rule, however, the only surgical operation performed consists in making a curvilinear incision in front of the rectum, which exposes . the prostate, and permits the surgeon to open and curet caseous foci. If an abscess forms, it should be evacuated by means of a perineal incision and cavities should be cureted and packed with iodoform gauze.

If it is determined that no operation is advisable, antituberculous treatment is employed. One should look to the patient's general health, administer urotropin, and avoid using instruments as much as possible; because, as Sir Henry Thompson has shown, instrumentation irritates the prostate, causes a

great deal of pain, and makes the disease worse in every case.

Retained and Malplaced Testicle.—In 1 person of 1000 there is undescended or ectopic testis. The testicle may be arrested in its passage to the scrotum (cryptorchism, single or double); it may remain in the lumbar region; it may reach the internal abdominal ring; it may lodge in the inguinal canal; it may emerge from the external ring, but fail to enter the scrotum; or it may pass into an unnatural position, as into the perineum or the crural canal (ectopia of the testis). The failure of descent may be unilateral or bilateral, but when bilateral the degree of descent is seldom the same on the two sides. The gland may be, but seldom is, functionally active. When retained in the abdomen it never has the power of spermatogenesis. Before puberty the testicle is usually normal, but after puberty there is practically always more or less atrophy. In about 1 case out of 5 there is spermatogenesis. A retained testicle is liable to attacks of orchitis and may become tuberculous or sarcomatous. In most cases there is neither pain nor tenderness, and the patient presents himself for treatment because a lump has appeared in the groin. In some cases there are sudden attacks of violent pain, accompanied by nausea (Rawling, on Incompletely Descended Testicle, in "Practitioner," August, 1908). A testicle in the inguinal or crural canal or in the perineum is far more apt to become sarcomatous than is one retained within the abdomen. Over 10 per cent. of cases of sarcoma of the testicle are in undescended glands. In 80 per cent. of individuals the testicles have descended at birth; most often it is the right testicle which fails to descend. Sometimes a testicle descends after being retained for months or even years. In Keyes' case it descended in the thirtieth year. Late descent usually causes hernia, and in 90 per cent. of all cases hernia exists. In double cryptorchism, in which the testicular function has been abolished, there is delayed union of the bony epiphyses and epiphyseal fractures are common, and there may be excessive growth of long bones. The same liability is noted in those subjected to castration in infancy. When such a

subject reaches manhood, he may develop son is usually seen only in children (Gross and Ser 1905). In operating on these cases we usually naculum and a vaginal tunic extending well

Treatment.—If one testicle is undescended and before puberty, if it lies in the canal, and the former should be removed if it is found im the scrotum. Both testicles should not be rembe placed within the abdomen. I would do th tainly enter and remain in the masculine gro missible in an adult, because he has definitely b line, and undescended or ectopic testicles in an functionally useless and menaces. If a testic it should not be operated upon unless it cause retained gland into the scrotum before the as after puberty, it will be almost certain to be fu testicle should be restored to the scrotum if possi Even when operation is performed to replace the ing. In Rawling's 20 cases only 4 were perman tors, however, claim better results. For instance from one to six years, and in 31 of them the res The method I employ is that advocated by through the aponeurosis, separation of the co usually in the posterior sac wall); removal of the and fibrous adhesions around the cord; the m fingers, closure of the canal as in hernia; sutur the external ring, as advocated by Dowd. Thi Bevan operates for a testicle within the canal vaginal process, removing all the coverings of th suspended by the vas and spermatic vessels or testicle a very wide range of mobility. A poc means of the finger, the testicle is placed in without suturing. The canal is now sutured as cord transplantation. There is a certain the the testicle after Bevan's operation. I believe ployed in the more severe cases. If there is no performed until between the eighth and twelft

Orchitis is inflammation of the testicle. cold, wet, traumatism or epididymitis, gout, m fever. The testicle is round, swollen, tender, is red and swollen, the tunica vaginalis is fille *Chronic* orchitis results from the acute form flammation, and is almost always combined wi

The treatment of the acute form consists as for epididymitis (page 1391). The chrone the causative lesion, if possible, the wearing plications of ichthyol or mercurial ointment, a of potassium by the mouth. Strapping with do good. Castration may be required.

Tuberculosis of the testicle may perhaps be primary, but in the vast majority of cases is secondary to tuberculosis of the prostate, bladder, or seminal vesicles. I have never seen a case I was certain was primary. As Keyes says ("Annals of Surgery" June, 1907), careful examination will show one of three conditions—tubercle bacilli in urine, indurations in the prostate, and vesicles or "a distinct haze in the urine due to prostatic catarrh." These patients are nearly always sterile. The disease may be preceded by pulmonary tuberculosis, peritoneal tuberculosis, anal fistula, renal tuberculosis, or tuberculous disease of bones or joints; and primary tuberculosis of the testicle may be followed by near or distant tuberculous lesions. In some cases involvement of the prostate exists, but cannot be detected (latent tuberculosis of the prostate); in other cases the prostate is in a state of subacute inflammation. The epididymis is always involved before the testicle and early chronic lesions are localized there for some time. In most cases the bacilli reach the prostate and vesicles by way of the blood, and reach the epididymis by way of the vas deferens, the lesions of the prostate and vesicles developing first or remaining latent. In some cases tuberculosis of the kidney or bladder is followed by tuberculosis of the testicle. The spread from the prostate, vas, or bladder is by epithelial infection. There is no evidence confirmatory of the idea of ascending infection from the urethra. In a child with an open vaginal process, tuberculous peritonitis may directly cause tuberculous epididymitis. The disease begins in one testicle, but in the vast majority of cases the other testicle becomes involved after a few weeks or months. If the other testicle remains free for three years, its chance of remaining free is good. If but one epididymis is involved, the testicle may not be affected for weeks or months. Von Bruns says that in 18 per cent. of such cases the testicle is not involved for six months; in 40 per cent., for over two months ("Archiv. f. klin. Chir.," Bd. 63, H. 4). It usually comes on gradually, but it may begin acutely, as I have seen in two instances during the progress of tuberculous peritonitis. An acute onset or an acute exacerbation of a chronic case usually means a mixed infection. The disease may follow a slight injury or inflammation, and is most common in young men, but may arise at any age. The causal influence of antecedent or existing gonorrhea is doubtful. Some maintain that sexual excess predisposes. There is often a family history of tuberculosis. A chronic case begins by swelling of the epididymis. Palpation detects one or two or several rounded nodules, or a diffuse hardening. In the latter case the epididymis is much enlarged, and there is usually a slight hydrocele. Rectal examination commonly detects nodules in the prostate and vesicles. In a few cases there are frequency of micturition, tenesmus, hematuria, and seropurulent fluid can be massaged from the vesicles and prostate and milked from the urethra. In some cases bacilli are found in the urine. In others the urine is hazy. Sooner or later nodules appear in the testicle. The vas is always swollen and may or may not be palpable. In an acute case one testicle is involved. The testicle is very painful and the epididymis is greatly swollen and smooth. The testicle quickly swells, there is always a hydrocele, and the scrotal skin becomes reddened. In a few days the acuteness of the symptoms subsides, but suppuration shortly occurs. In any case of tuberculosis of the testicle nodules tend to soften and run together.

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After a time the skin may become red and a a caseous breaking-down epididymis or testicle mixed infection, but in many cases where soften there is mixed infection. The duration of the cent. of the 100 cases carefully studied by Ke years after the beginning of the trouble, and 4 operated upon) seemed free from tuberculous of the cases that suppurated were apparently of Surgery" June, 1907). Except in the acute of if at all, painful, and tenderness is trivial. In



Fig. 830.—Obstructive hyperemia for the testicles. by the patient, crossed. A piece of tape is placed benea and Schmieden).

hydrocele forms. In a questionable case t employed. If a hydrocele exists, the fluid she and cultures be made from it.

Treatment.-Before attempting any open patient is placed recumbent, the diseased te batting is placed around the neck of the scrotu of a caliber of 25 F. is wound twice around clamp. If both testicles are diseased, both ar scrotum is embraced by the tube with the requi treatment is applied for two or three hours a de best be recumbent during the application. In pensory and gets about. During the use of Bie treatment is required (page 245). If a cold abs antiseptically. If Bier's treatment fails, consider

An acute case requires unilateral castration. If, in a chronic case the disease is limited to the epididymis or to the epididymis and vas, resect the epididymis (epididymectomy) and the vas deferens. If the testicle is diseased, orchidectomy is performed. It was long believed that orchidectomy was useless if the vesicles and prostate were involved, but Koenig and others maintain that vesicular and prostatic tuberculosis improves after removing the diseased testicle or epididymis. If the epididymis of each testicle is involved, bilateral epididymectomy should be performed. When both testicles are diseased and other organs and structures are not extensively involved, bilateral orchidectomy is performed or, better, the testicle which is most diseased is removed and the diseased portion of the other is extirpated. Cumston points out that the testicle may be diseased and yet even when exposed the disease not be detectable. Hence in doing epididymectomy he splits open the testicle to see if it is diseased. If it is not diseased he sutures it with catgut and removes the epididymis. If it is diseased, he considers the advisability of unilateral orchidectomy (Charles Greene Cumston, in "Annals of Surgery" June, 1909).

In association with and after operation employ antituberculous remedies, order a nourishing diet, send the patient to a good climate, and insist on an open-air life. A very large percentage of unilateral cases are cured by opera-

tion (over 40 per cent.). Some few bilateral cases are cured.

Orchidectomy, or Castration (Excision of a Testicle).—Bilateral castration should never be performed without deliberate consideration. It often produces grave mental disorder. This is in part the result of the depression attendant on knowing that the glands are gone and in part in the loss to the organism of the internal secretion of the testicle. A boy castrated before puberty never becomes potent. A man may retain potency for a considerable time. I removed a tuberculous kidney from a man who had been castrated by my colleague. Dr. Horwitz, two years before, yet he was still able to have intercourse. Unilateral orchidectomy does not make a man either sterile or impotent and does not produce mental disturbance. In orchidectomy an incision is made over the cord, commencing just outside the external ring and running down over the base of the tumor. Clamp the cord and divide it near to the ring, remove the testicle, ligate the spermatic artery alone, and then ligate the entire thickness of the cord. The cord is ligated with chromic gut. The skin is sutured with silkworm-gut. Drainage is not required. It is often advisable to remove a considerable amount of scrotal skin.

Epididymitis, or inflammation of the epididymis, is usually due to inflammation of the urethra. It is apt to occur in the stage of decline of a gonorrhea, and is announced by a complete cessation of the discharge. It may result from the passage of a urethral instrument, the voiding of urine which contains fragments of calculi, or as a complication of prostatic hypertrophy. Acute epididymitis is characterized by swelling about the testicle, pain in the groin, and tenderness over the posterior part of the testicle. The pain becomes acute, swelling rapidly increases, and the constitution sympathizes. The swelling is due partly to engorgement of the epididymis and partly to fluid in the tunica vaginalis (acute hydrocele). Chronic epididymitis is usually linked with orchitis, and it follows an acute attack or a chronic

urethral inflammation.

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Treatment by septic puncture with a tend will relieve tension and pain. Leeching over the use of an ice-bag, elevation, application of laxatives and opium constitute the usual treat



Fig. 831.-Hydrocele of tunica vaginalis (Horwitz).

In nearly one-half of the cases the testicle is used scended. In every case there is a long mesory normally placed, torsion of the cord will hardly nals of Surgery," Aug., 1901). The twisting method the left. The symptoms arise suddenly, and use cases a hernia also exists. When the rotat hemorrhages take place into it, and gangrene undescended or partially descended testicle that are noted in the abdomen or the groin. If the tum, the gland feels nodular and the epiditoms are sudden pain, vomiting, moderate shows a swollen testicle in the scrotum. The stroughing. The symptoms resemble those or less violent, and the bowels are not obstructed.

Treatment.—An incision should be made and the testicle is not gangrenous, untwist and I by a catgut stitch. If the testicle is gangren us that in 88 per cent. of cases the testicle is cording to Scudder, there are 32 cases on reco I was not, but all recovered; in 3 the testicle ("Annals of Surgery," Aug., 1901).

Vaginal hydrocele—chronic hydrocele (
lection of fluid in the tunica vaginalis testis.
may cause it, but in most instances the caus
inflammation exist. The fluid is albuminous,
taneously; it is thin, straw-colored, and may
The testicle is at the lower and back part of
fluctuates, is translucent, grows from below u

of an exploring-needle permits the yellow fluid to flow out. Sometimes a hydrocele has an hour-glass shape. This is the hydrocele "en bissac" of the French. In this condition (Fig. 832) two cavities exist, usually but not invariably communicating. The constriction between the cavities is due to inflammatory thickening.



Fig. 832.—Hydrocele "en bissac." This hydrocele extends up the cord into the inguinal canal and to the internal abdominal ring (Horwitz).

Treatment.—Simply tapping the sac with a trocar is only palliative; air must run in as fluid runs out, and suppuration may occur, which will be dangerous without drainage. Never tap a rigid sac. The injection of irritants should be abandoned, as it exposes the patient to serious danger because

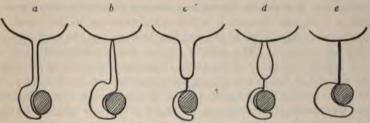


Fig. 833.-Varieties of hydrocele: a, Congenital; b, infantile; c, funicular; d, encysted; e, vaginal.

of inflammation occurring without provision for drainage. Hearn incises the sac, dries its anterior with bits of gauze, swabs it out with pure carbolic acid, packs it with iodoform gauze, and dresses it antiseptically. The packing is removed in twenty-four hours and the wound is allowed to close. In most cases I prefer this method. If the sac is rigid and will not collapse, either stitch it to the skin and pack it or excise a large portion of its parietal layer and insert a drainage-tube (Volkmann's operation). It has recently been

proposed to tap the sac with a trocar and place as a drain for some days, and to dress as

Longuet's operation is easy and successfuposition of the testicle. It was introduced Méd.," Sept. 21, 1901). A local anesthetic inches in length is made. The testicle is lifter and all the other coats except the skin fall tog for the cord. One catgut suture will hold to made for the testicle beneath the inner edge of the fingers. The testicle is rotated on its lon ity. The testicle rests against the scrotal septhe cord covered with tunic. The skin is su

Congenital hydrocele (Fig. 833, a) is funicular process into the tunica vaginalis, runs back into the peritoneal cavity, from treatment is the application of a truss to obli

Infantile hydrocele (Fig. 833, b) is a comprocess and the tunica vaginalis, the funiculation but not below. The **treatment** is to puncture wall with a needle.

Encysted Hydrocele of the Cord ( the funicular process is obliterated above and these two points and fluid collects. The tre infantile hydrocele. If this fails, incise and p

Funicular Hydrocele (Fig. 833, c).—' below, but is open above. Raising the pelvinto the peritoneal cavity. The treatment is

Encysted hydroceles of the testicles and Diffused hydrocele of the cord is simply eder hernia is the distention of a hernial sac with p

Hematocele (Fig. 834).—Vaginal hematocele alis, the result of traumatism, a tumor, or the tapyriform tumor, which fluctuates, but which scrotum is livid, and the testicle is below are encysted form of hematocele of the cord is a bileeding has occurred. The diffused form into the cellular substance of the cord. Encounter the tellular substance of the cord.

The treatment of a recent case of vaginal to bed, support the scrotum, and apply an i swelling does not soon abate, incise, irrigate, a

Varicocele is varicose enlargement of the spermatic cord. The veins are thick convoluted. The assigned causes are strainiful occupation requiring prolonged standing. States desire is a cause. Hereditary predisposition left-sided than right-sided varicoceles, becaut valves and empties into the vena cava at an acceptable.

vein has no valves (Brinton) and empties into the left renal vein at a right angle. Varicocele is a very common condition. The elder Senn found it in per cent. of 10,000 recruits. An irregular swelling exists in the scrotum and extends up the cord. This swelling feels like "a bag of earth-worms"; it exhibits a slight impulse on coughing; the scrotal skin and cremaster muscle are attenuated; the testicle lies at the bottom of the swelling and is softer and smaller than normal; the swelling diminishes on lying down and increases on standing or on making pressure over the external ring. The scrotum is pendulous and the scrotal skin frequently contains varicose veins. The testicle may be soft and shrunken. There is usually some discomfort, aching,



Fig. 834. - Acute hematocele of tunica vaginalis the result of traumatism (Horwitz).

or dragging in the testicle and the groin, and even neuralgic pain in the cord. There may be no discomfort of any sort. A large varicocele may be free from discomfort and a small varicocele may produce much annoyance, or vice versa. There are sometimes mental depression and hypochondriasis. As a man reaches middle age a varicocele usually ceases to give trouble.

Treatment.—In treating varicocele, reassure the patient: tell him there is no real danger of impotence; order cold shower-baths, correct constipation and indigestion, give occasional tonics, and order the patient to wear a suspensory bandage. If the testicle becomes much atrophied, if the pain and the dragging are annoying, or if the mind is much depressed, operate (page 462).



An amputation is the cutting off of a li moval of a limb or a portion of a limb at a jo Amputation may be necessary because of t gangrene, of tumors, of intractable disease c will not heal, of traumatic aneurysm, etc.

because of the existence of a defect or disease

Classification.—Amputations are claime of operation after the injury: a primare after the occurrence of the accident—as soon and before he develops fever; a secondary time after the accident, suppuration having

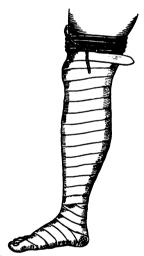


Fig. 835.—Esmarch's elastic bandage.

intermediate amputation is performed during the development of suppuration. (2) As to divided or according to which joint is cut the

situation of the flap.

In performing an amputation maintain the hopelessly damaged portion; sacrifice as ble; prevent hemorrhage during the amputa the operation; have enough sound tissue in enough skin to cover the muscles; and secur

Hemorrhage may be prevented by the e 835). Ordinarily we can apply this bandage the line of the prospective incision, encircle t the thin tube shown in tle cut), and remand band, asepticized before using, are all been carefully sterilized. After the band has



F

not freely or forcibly be moved, because of the danger of tearing muscles which are firmly fixed by the compressing band. When elastic compression is used in an operation the surgeon should be very careful to tie every visible vessel. The paralysis of the small vessels induced by pressure often prevents bleeding, and unless their mouths be found and the vessels be tied reactionary hemorrhage will occur. Reactionary hemorrhage is the great danger after the use of the Esmarch bandage, and paralysis or sloughing may also follow

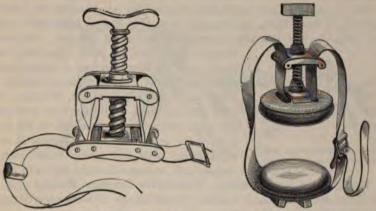


Fig. 837.-Petit's spiral tourniquet.

Fig. 838.-Charriére's tourniquet.

its employment. If there be an area of suppuration or of gangrene or an extra-osseous malignant growth, do not apply the bandage as directed above. One bandage can be applied from the periphery to near the lower border of the area of growth or infection, and another, from near the upper border of this area, up the limb. If the bandages are applied in this manner the contents of the diseased area (tumor-cells and fluid or septic products) are not squeezed into the circulation. In cases like the above many surgeons



Fig. 839-Catlin, knife, and saws for amputation.

hold the extremity in a vertical position for five minutes, lightly stroking it toward the body with the hand, and at once apply the constricting band. As a matter of fact, this plan satisfactorily empties the limb of blood, and it is not necessary in any case to force the blood out by elastic compression. Some surgeons prefer the tourniquet. Figs. 837 and 838 show two forms of tourniquet. To apply Petit's tourniquet, place the plates in contact, apply a small, firm compress over the artery and a broad thick compress over the outer surface of the limb, buckle the tapes around the limb so that the plate

is over the broad pad, and tighten the tour with the screw (Fig. 836). When a tourniq during transportation, bandage the limb, sew and place the plates of the instrument over tourniquet may be used upon the brachial ari joint disarticulations Wyeth's pins are passed of blood the band is fastened above them. from slipping.

The instruments and appliances required apparatus or tourniquet, amputating knives saws (Fig. 839), a lion-jawed forceps, bon



1398

Fig. 840.—Amputation of arm by the circular method (Druitt).

elevator, retract static, and too aneurysm-needle tures, sutures of ages, and solution the thigh and ar forearm: it is meight inches with cutting tails on

Methods of Amputating.—Transvers and 841).—This is the oldest method of ampucision is at a right angle to the

axis of the limb. Kocher considers also as a circular incision an oblique cut around the limb if the line of the incision "continues in one direction" (Kocher's "Text-Book of Operative Surgery," translated by Harold J. Stiles). This method is called the oblique circular amputation. A racket incision is formed by adding a longitudinal cut to a transverse circular cut. If the edges are rounded, the lanceolate incision is formed. Rectangular flaps are formed when two longitudinal incisions are added to a transverse circular cut. If the corners of a rectangular flap are trimmed, rounded flaps are formed. The three last-mentioned plans are considered under the head of the Modified Circular Amputation (page 1399).

The surgeon should stand to the right of the limb and use a long

Fig. 841.-Th

from heel to point (Fig. 840). After an assistant has retracted the skin the operator divides the soft parts by a series of circular cuts. He does not cut at once to the bone, but divides the skin and subcutaneous tissues. At the retracted edge of the first cut the superficial muscles are divided, and after these muscles retract the deep muscles are divided. The periosteum is incised with a bone-knife and pushed up with an elevator, and after the application of the retractors the bone is then sawed, the saw starting from heel to point. A periosteal flap can be made to cover the end of the

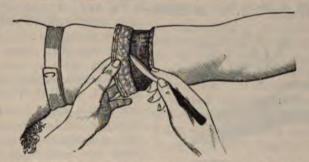


Fig. 842.-Circular amputation; dissecting up the skin-flap (Esmarch).

bone, but it is unnecessary. In this amputation is formed a cone whose apex is the bone and whose base is the skin-edge. Figure 841, from Kocher, shows the steps of the operation and the shape of the resulting stump. In one form of circular amputation (amputation à la manchette) the retracted skin is cut by a circular sweep of the knife, a cuff of skin and subcutaneous tissue is freed and turned up, and the muscles are cut circularly at the edge of the turned-up cut (Fig. 842). The pure circular amputation is performed on the arm and the thigh; the amputation à la manchette is performed chiefly through the wrist and the lower forearm.

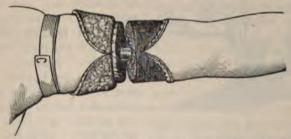


Fig. 843 .- Modified circular amputation; skin-flaps and circular cut through muscles (Esmarch).

If there is more sound skin upon one side of the extremity than upon the other, the transverse circular incision sacrifices more of the limb than is necessary and the oblique circular is preferable. An objection to the transverse circular incision is that the cicatrix lies directly at the end of the stump and is liable to cause pain when subjected to pressure.

Modified Circular Method.—In this operation the circular skin-cut may be modified by making a vertical incision to join the first wound, the

at a surfac to th The that a surro tical · draw cles a being Koch crease The on a of the cut tr the tra flap broug metho circul by a partic R round

muscles being cut by a circular sweep (rack vertical skin-incisions (rectangular flaps). by rounding the edges of the flaps which Liston's modification consists in dissecting u mentary flaps and in dividing the muscles known as the "mixed method." The modi the thigh, the leg, the arm, and the forearm.

Oblique Circular Method (Elliptical M lower ends of the incision as shown in Fig

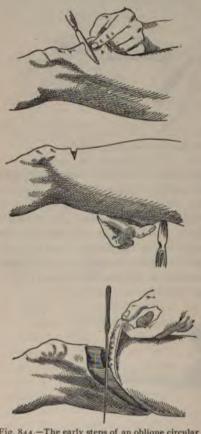


Fig. 844.-The early steps of an oblique circular amputation (Kocher).

"lanc ampu skin oval v and th are cu a long bone (Fig. 854, a, b) extends from the po is called the "racket" amputation. If the le cut, the operation is known as a T-ampu

and shoulder-joints; the T-operation may be Flap Method .- A flap may be composed and muscle, but the skin-flap must always be that the latter will be covered by it. A flap badly, but the best flap has a moderate amo

operation is performed at the metacarpoph

cover the muscle and enough muscle to cover the bone). Flaps may be single



Fig. 845.—Amputation of the thigh by transfixion (Gross).

or double. Double flaps may be lateral or antero-posterior, square or U-shaped, equal or unequal, and they may be cut by transfixion (Fig. 845), by cutting from without inward, by dissection, or by cutting the skin from without inward and the muscles by transfixion.

Completion of an Amputation.—
When an amputation is completed, tie the main vessels, pull down the nerves and cut them high up, smooth the flaps, take off the constricting band, and after arresting hemorrhage apply sutures. In some cases the deep parts are stitched with a continuous catgut

suture and the superficial parts are closed with silkworm-gut; in other cases the deep parts are not stitched at all, the skin alone being sutured with silkworm-gut. Drainage-tubes should be used except in amputations of the fingers and toes.

## SPECIAL AMPUTATIONS.

Fingers and Hand.—In amputating the thumb and index-finger save every possible scrap of tissue. In either of the fingers, if it be necessary to

amputate above the middle of the middle phalanx, the attachment of the flexor tendons will be cut off and the finger will be liable to project directly backward, so that it is better with these fingers either to disarticulate at the metacarpal joints or to stitch the flexor tendons to the periosteum. The flexor tendons

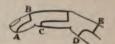


Fig. 846. —Amputation of the finger.

have fibrous sheaths extending from the proximal end of the distal phalanx

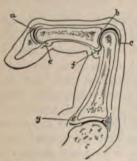


Fig. 847.—The line of the joints in the flexed position of the finger; a, Extensor longus digitorum; b, interossei and lumbricals; c, extensor longus digitorum and interossei; g, interossei and lumbricals; f, flexor sublimis; e, flexor profundus (Kocher).

to the metacarpophalangeal articulations, these sheaths being thin and collapsible opposite the joints, but being thick and rigid opposite the shafts of the bone. The fibrous sheath is known as the theca, and when it is cut in an amputation it should be closed, otherwise it may carry infection to the palm of the hand. The theca does not exist over the distal phalanx, and it is not distinctly visible over the joint between the distal and middle phalanges. To effect closure over the shaft of a bone, strip up the periosteum and pass catgut sutures vertically through the theca and the periosteum (Treves). In amputation of the fingers and the thumb an Esmarch bandage is unnecessary, though pressure may be made upon the arteries at the wrist. Only two or three ligatures are necessary. Close with a very few sutures, so as to favor drainage between the threads.

The distal phalanx is best removed by a long palmar flap (Fig. 846, A).

The palmar flap (A) is marked out by cutting through the skin and subcutaneous tissue. The incisions are next carried to the bone, the flap is dissected from the bone, the finger is strongly flexed, a transverse incision (B) is carried across the dorsum on a level with the base of the third phalanx, the soft parts are pushed back, the joint is opened, the lateral ligaments are cut from within outward, the third phalanx is forcibly extended, and the remaining structures are cut from below upward. Fig. 847 shows the lines of the joints when the finger is flexed. The middle phalanx can be removed by the same method (c, Fig. 846). The proximal phalanx can be removed by a long palmar flap or by a long palmar and a short dorsal flap (D, E, Fig. 846).

Disarticulation at a metacarpophalangeal joint is best performed by the oval method. The incision upon the dorsum (A) is begun just above

the head of the metacarpal bone, is carried down to beyond the base of the phalanx, and involves the skin only (Figs. 848 and 849). One



Fig. 848.—A, Disarticulation of a metacarpophalangeal joint; c, amputation of a finger with the metacarpal bone.

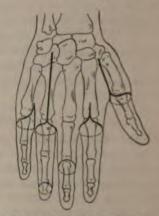


Fig. 849.—Disarticulation of the little finger and index finger. Disarticulation of the ring finger with its metacarpal bone. Disarticulation of the thumb with its metacarpal bone (Kocher).

incision sweeps around the finger at the level of the web, going only through the skin (B); the finger is extended and the palmar cut is carried to the bone; each lateral incision is carried to the bone while the finger is bent in the opposite direction, the flaps are dissected back to the joint, the finger is strongly extended, the joint is opened from the palmar side, and disarticulation is effected. Cutting off the head of the metacarpal bone improves the appearance of the stump but weakens the hand, hence in a workingman it must not be done unnecessarily. If it is necessary to remove a metacarpal bone, the incision (c) is made from the carpometacarpal joint-

Amputation of the thumb through its distal or proximal phalanx is performed identically as is an amputation of a finger. Amputation of the thumb, with a portion or the whole of its metacarpal bone, is performed by the oval or racket incision (Fig. 849).

Disarticulation at the wrist-joint can be done by the oblique circular method (Fig. 851) or by a double flap. In the double-flap amputation a dorsal flap is made by carrying a semilunar skin-incision between the styloid processes; the skin is lifted, the wrist is forcibly flexed, the joint is opened

by a transverse cut, and a long semilunar palmar flap which includes only the skin and fascia is made by dissection. Kocher prefers to amputate by an



Fig. 850. —Modified circular amputation of the forearm (Bryant).

oblique incision. The lower end of this incision is about the middle of the palm and the upper end is in the line of the wrist-joint (Fig. 851). The hand is strongly flexed, the extensor tendons are divided, the posterior ligament of the joint is incised, and incisions

below the styloid processes divide the lateral ligaments and certain tendons. The flexor tendons are separated from the bone and are divided so as to remain in the palmar flap.

Amputation through the forearm may be effected by the circular method (Fig. 851), the modified circular, or the flap operation. The modified circular is an excellent plan. A semilunar dorsal skin-flap and a semilunar skin-flap on the flexor surface are made. The flaps are raised, the muscles are

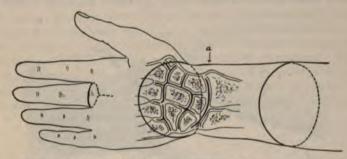


Fig. 851.—Disarticulation of the middle finger. Disarticulation at the wrist-joint. Amputation through the forearm by the oblique circular method (Kocher).

cut circularly (Fig. 850), the interosseous space is cleared with the knife, a three-tailed retractor is applied, the periosteum is pushed up, and the bones are sawn half an inch above the flap. In sawing the bones, start the saw upon the radius, draw it from heel to point, make a furrow on the radius and



Fig. 852 .- Disarticulation of the elbow-joint by the oblique circular method (Kocher).

ulna, and saw both bones at the same time. After sawing, cut away any irregular edge with bone-pliers. In the lower third Teale's amputation may

be done, the dorsal flap being the long one. In Teale's amputation rectangular flaps are made. The long flap is equal in width and length to one-half the circumference of the limb at the point where it is to be sawn. The short flap is equal in width to the long flap, but is only one-fourth its length. The two longitudinal cuts are at first taken only through the skin, but the two transverse cuts go at once to the bone. The flaps are dissected up from the interosseous membrane and the bone. In the middle or the upper third of a fleshy arm two semilunar skin-flaps can be cut from without inward, and the muscle can be cut by transfixion.

Disarticulation at the elbow-joint can be done by the elliptical method or by a long anterior and short posterior flap. In Kocher's oblique operation the incision begins anteriorly over the joint-line and ends posteriorly a hand's breadth below the summit of the oiecranon (Fig. 852). A posterior flap which contains the integument, insertion of the triceps, the anconeus, and periosteum is dissected up until the posterior surface of the humerus is reached. The joint is opened anteriorly by a transverse incision.

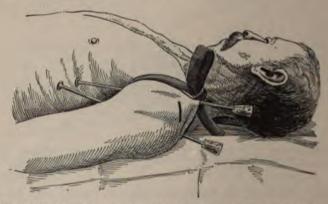


Fig. 853.—Use of Wyeth's pins in amputation at the shoulder-joint. The acromion is marked by a black line (Keen).

and the radiohumeral articulation is opened from without inward (Kocher). In the double flap operation the forearm is partly flexed and a skin-cut marks out a long anterior flap, the knife being entered opposite the external condyle and being withdrawn one inch below the internal condyle. The muscles, which are bunched forward, are cut by transfixion. A posterior semilunar flap is made, which separates the attachments of the radius, the ulna is cleared, and the triceps is cut at its insertion (Bell). Gross advocated sawing through the olecranon and the inner trochlear surface.

Amputation of the arm is best performed by marking out with a knife two equal semilunar anteroposterior flaps, the first cut being carried through the skin alone, the muscles being then transfixed with a long knife. Teale's method is shown in Figs. 380 and 381. The circular or the modified circular amputation may be performed.

Disarticulation at the Shoulder-joint.—In this operation some surgeons use Wyeth's pins to hold the Esmarch band in place. The anterior pin is entered at the middle of the lower margin of the anterior axillary fold, and emerges one inch within the tip of the acromion. The posterior pin is entered at a corresponding point on the posterior axillary fold, and emerges more posteriorly than the first pin and an inch within the tip of the acromion. After the extremity has been drained of blood by the Esmarch bandage or by stroking and a vertical position, the Esmarch band is applied above the pins (Fig. 853). With a competent assistant, however,

the pins are not necessary, the surgeon divides his main vessels as the last step of the operation, and the assistant controls them before they are cut and until they are tied, with his thumbs slipped back of the bone.



Fig. 854.-Amputation at the shoulder-joint : a, b, c, d, Larrey's Operation .- In this method of shoulder-joint e, Larrey's opera-

disarticulation the limb is held from the side and an incision tion; f,g, Dupuyis made down to the bone, the incision beginning just below tren's operation. and in front of the acromion and running vertically for four inches down the outer surface of the arm (Fig. 854, a b). From the center of this incision an oval incision (c d, c e) is carried around the arm, the inner aspect of the oval reaching as low as the lower end of the vertical cut. The oval incision at first involves only the skin and subcutaneous tissues. The anterior structures are divided close to the bone, and the posterior structures are next cut. To disarticulate, cut the capsule transversely upon the head of the bone; while the arm is rotated outward cut the subscapularis, and while the arm is rotated inward cut the supraspinatus and infraspinatus and the teres minor. Cut away any

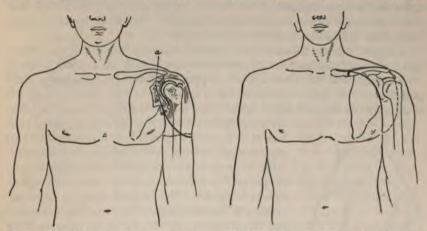


Fig. 855. - Disarticulation at the shoulder-joint by Kocher's method (Kocher).

Fig. 856.-Removal of the entire upper extremity (Kocher).

tissue holding the humerus to the body, hanging nerves, capsule-fragments, and tissue-shreds, insert a tube, and sew up the wound vertically. Bell advises an oval incision with a racket handle. Spence used an anterior racket incision.

Kocher's Operation.-Kocher makes an anterior lanceolate incision (Fig. 855). The incision begins over the clavicle just external to the coracoid process of the scapula, and is carried downward, dividing, as it advances, the anterior fibers of the deltoid muscle. "Bleeding vessels and the cephalic vein are ligatured. In the upper part of the wound the acromial branches of the

acromiothoracic artery are also ligatured. The bone at the edge of the deltoid (only the up divided). The capsule is divided over the less groove. The periosteum, the insertions of major, latissimus dorsi, and teres major are de The capsule, along with the insertions of the and teres minor muscles, is also detached fro and from the great tuberosity. The head of truded from the wound. In cutting down over necessary to ligature the circumflex arteries; The racket incision is now co must be tied. circularly at the level of the axillary folds. The easily isolated, the former being ligatured and "Text-book of Operative Surgery," translated cautions us to avoid the circumflex nerve whi deltoid is the muscle of the stump.

Dupuytren's Operation.—In Dupuytren's a U-shaped flap is marked out by a skin-incisis putation is to be at the right shoulder, the arm knife is entered at the root of the acromion, fol and is withdrawn at the coracoid process, the and pulled off from the chest. If the left sho procedure is reversed (Treves). The knife is and raises a flap composed of this muscle, the disarticulation is effected as in Larrey's methol back of the bone and a short internal flap is cut

Lisfranc's amputation is by transfixion wi and a posterior flap, and can be performed ver

Amputation of the Entire Upper putation.—The Interscapulo-thoracic Amputation above the shoulder-joint, was

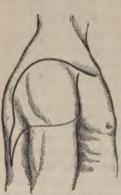


Fig. 857.—Removal of the whole upper extremity.

By it are removed the tion of or the entire c ployed in cases of mali jury. The operation rhage, and as a preli should be ligated. T cording to the necessit tion Berger divides th outer and middle third of the bone; ligates an cuts the anterior flap marks out the posterio tion by dividing the str blade to the chest. ing is profuse. Fig. 8 the operation. Fig

The usual procedure of tying the th artery as a preliminary measure possesses artery is very deeply situated at this point, is in close relation with the pleura, and is covered to a considerable extent by the vein; and the phrenic nerve is very near. Le Conte resects the entire clavicle before tying the vessels. He maintains that then one of two courses may be taken: The veins may be severed first, and afterward the artery may be exposed and tied. When this is done, the amount of blood remaining in the arm is lost. The procedure that he selects as the best, however, is to expose the axillary artery as high up as possible, and place a temporary ligature around it; then elevate the arm, empty it of blood, place a permanent ligature around the third part of the subclavian artery, and divide the artery in this portion of its course (Robert G. Le Conte, "Annals of Surgery," Oct., 1902). If the scapula

per cent. (Berger, "Revue de Chir.," Aug., 1905). Amputation of the Toes and the Foot.—Only through the great toe is partial amputation performed, and it is effected by the formation of a long plantar flap, just as a long

is involved in the tumor, the mortality is something over 23



Fig. 858 .- Amoutation of the toes with and without the metatarsal

palmar flap is formed from the finger. Amputation at the metatarso-phalangeal joints is performed by an oval or racket incision (Fig. 858, c). Amputation of a toe with removal of its metatarsal bone is shown in Fig. 858, a b and de.

Disarticulation at the Tarsometatarsal Articulation.-Lisfranc's Operation (after Treves).-In order to amputate the right foot by

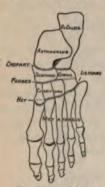


Fig. 850. - Lines in amputations of the foot (Gross).

this method begin an incision on the outer border of the foot, behind the tubercle of the fifth metatarsal bone; carry the incision forward one inch and sweep it across the foot half an inch below the tarsometatarsal articulations; bring the incision to the inner edge of the foot, half an inch in front of the articulation of the tarsus with the first metatarsal bone, and carry the cut straight back along the inner margin of the foot until it reaches a point three-fourths of an inch above the articulation of the metatarsal bone of the great toe. A very short semilunar dorsal skin-flap is thus formed. Fig. 864 shows the flaps as cut by Kocher. After the skin-flap has been dissected back for a quarter of an inch the tendons are divided, and the flap, which now contains all the soft parts, is dissected back to above the joint. A long plantar flap is cut, reaching from the origin of the first flap to the necks of the meta-

tarsal bones. The skin-flap is dissected up until the hollow behind the heads of the metatarsal bones is reached, when, with the toes in extension, the tendons are cut across and a flap composed of all the soft parts is dissected up to above the tarsometatarsal joint. Figs, 859 and 864 show the line of Lisfranc at the tarsometatarsal articulation. The joint is opened from the outer side according to the following rule: in separating the fifth metatarsal direct the edge of the knife toward the distal end of the first metatarsal; in separating the fourth metatarsal direct the knife toward the middle of the first metatarsal; in separating the third metatarsal carry the knife almost directly across. The separation is facilitated by bending down the front of the foot, and at the same time the tendons of the peroneus brevis and tertius are divided. Open surfaces. The greatest difficulty is met with at the inner side in clearing the projecting sustentaculum tali" (Kocher's "Text-Book of Operative

Surgery," translated by Harold J. Stiles).

Disarticulation at the Ankle-joint.—Syme's Method.—The foot is held at a right angle to the leg, and a skin-incision is carried, from just below the external malleolus, straight across or a little backward across the sole to a corresponding point on the opposite side. Do not take this incision near to the inner malleolus, as to do so will endanger the posterior tibial artery. The incision is carried to the bone, the flap being pushed back and separated from the bone by means of a strong knife and the thumb-nail until the tuberosity of the os calcis has been reached. The foot is now extended and a transverse cut is made across the dorsum, joining the two ends of the first incision; the ankle-joint is opened, the lateral ligaments are cut, disarticulation is effected, and the foot is finally completely removed by severing the tendo Achillis. A thin piece of bone including both malleoli is sawn from the tibia and fibula. The flap is perforated posteriorly to secure drainage (Fig. 381).

Pirogoff's Method.—Flex the foot to a right angle with the leg. "Make an incision from the tip of the internal malleolus across the sole, a little in front of the long axis of the tibia, to a point in front of the apex of the external malleolus down upon the bone."\* Dissect the flap backward from the calcaneum for a quarter of an inch, but do



Fig. 868.—Lines of section of the os calcis and the bones of the leg in Pirogoff's amputation.

not dissect the flap from the posterior portion of the os calcis. Join the extremities of the first incision by another cut which reaches to the bone, and which is "half an inch in front of the lower extremity of the tibia" (Bryant); but saw off this bony projection obliquely and leave it adherent to the tissues. The saw is used after disarticulation of the ankle-joint; it is passed behind the

astragalus, cutting downward and forward, sawing the os calcis obliquely, and leaving a considerable portion in place in the flap. The lower ends of the tibia and fibula are well exposed by raising the anterior flap slightly; the sawing is begun anteriorly just above the articular surface, and is completed half an inch above the articular surface posteriorly. The lines a and b (Fig. 868) show the sections made by the saw. The sawn surface of the os calcis is brought into contact with the sawn surfaces of the tibia and fibula, and the flaps are sutured.

Amputations of the Leg.—The so-called "point of election" is at the 
\*"Operative Surgery," by Joseph D. Bryant.

upper part of the middle third of the leg. Seventy years ago Liston advised

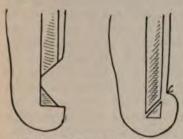


Fig. 869.—Diagrammatic representation of amputation of the leg after the method of Bier.

surgeons not to amputate in the lower third of the leg because of the scantiness of the soft parts, because the stump is apt to ulcerate, and because it is uncomfortable in an artificial leg. These views have been much modified. The amputation near the ankle is safer than the amputation near the knee, and artificial legs are now made which may be worn with comfort. In amputations of the leg by the long anterior flap, cut through the skin, dissect up the anterior muscles with the flap, and cut all the posterior tissues

with a single-transverse sweep. Amputation by the rectangular flap, Teale's method, is very useful (see page 1404). The long flap is anterior, and is in length and breadth equal to one-half the circumference of the limb. The short flap is one-fourth the length of the long flap. The flaps are dissected up, the bones are sawn, the long flap is turned upon itself, and its edges are sutured to the edges of the short flap.

Bier suggests a plan (Fig. 869) to increase the supporting power of the stump after a leg-amputation. After the wound has healed, a wedge-shaped piece of bone is removed above the level of the stump. The lower extremity is turned forward and upward through an arc of 90 degrees, and unites in this position (Zuckerkandl's "Operative Surgery"). Thus the medullary cavity

is closed and the skin which must bear pressure is healthy and free from cicatrices; and as the muscles are still attached to the bone, they do not undergo atrophy.

Sédillet's leg-amputation (Fig. 870) is by a long external flap. A longitudinal incision is made along the inner edge of the tibia, the tissues are drawn toward the fibula, a knife is introduced and passed to the outer edge of the tibia, just touching the fibula, and is brought out posteriorly, thus transfixing the calf-muscles and cutting an external flap. A convex incision is made on the inner side, the bones are cleared and are sawn one inch above the flaps, half an inch more being taken from the fibula than from the tibia, and the tibia being bevelled anteriorly.

Modified Circular Amputation of the Leg.—Cut semilunar skin-flaps, lay them back, and cut circularly to the bone at the edge of the turned-up flap. Another method of modified circular amputation is by adding to the circular cut a vertical incision down the front of the leg. In sawing the



Fig. 870.—Sédillot's amputation of the leg (Wyeth).

bones of the leg the surgeon, who stands to the outer side of the right leg or to the inner side of the left leg, divides the fibula first, and at a higher level than the tibia, and bevels the anterior surface of the tibia. In sawing the left fibula the saw points to the floor; in sawing the right fibula it points to the ceiling.

Amputation of the Leg by a Long Posterior and a Short Anterior

Flap.—In this operation a posterior U-shaped flap is made equal in length and breadth to the diameter of the limb. The skin-incision is begun one inch below the point where the bone is to be sawn, and behind the inner edge of the tibia, and is carried to a point posterior to the peronei muscles. The



Fig. 871.—Amputation of the leg by a long posterior flap (Gross).

gastrocnemius muscle is divided transversely at the level of the flap, the soft parts on either side in the line of the flap being cut to the bone. Through these vertical cuts the muscles are lifted from the bones and are divided through their lower part by cutting from within outward. The anterior flap is formed by making a semilunar skin-flap and by cutting the muscles across at its retracted edge (Fig. 871).

Amputation of the leg by lateral flaps is not a popular operation, as it offers too much encouragement to subsequent protrusion of the bone.

Amputation just below the Knee.—The seat of election is one inch below the tuberosities. No muscle is needed in the flap. Cut two flaps of skin, equal in size and semilunar in shape, these flaps beginning anteriorly two inches below the tuberosity of the tibia. One flap is antero-external and the other is postero-internal. The flaps are pulled up, the anterior muscles are cut as high up as possible, and the posterior muscles are cut through the middle of the portion exposed (Bell). The bone is sawn one inch below the tuberosity.

Disarticulation of the Knee.—In disarticulation by the long anterior flap, make a long anterior skin-flap, incise the ligament of the patella, turn up a flap containing the patella, open the joint, and complete the disarticulation by cutting from within outward and downward. The knee may be disarticulated by means of a long anterior and a short posterior flap. Kocher prefers the oblique incision (Fig. 872). This secures an anterior flap. The leg is so

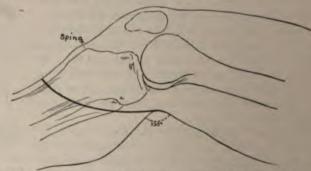


Fig. 872.-Kocher's oblique incision for disarticulation at the knee-joint (Kocher).

held that it makes an angle with the thigh of 135 degrees and "the incision falls in the continuation of the long axis of the thigh" (Kocher's "Tentbook of Operative Surgery," translated by Harold J. Stiles). The posterior part of the incision is opposite the line of the joint and the anterior part of the incision ends four finger-breadths below the tibial tubercle.

Amputation through the Femoral Condyles.-Syme's Method by

Long Posterior Flap.—Carry a skin-incision, with a very slight downward curve from one condyle to the other, across the middle of the patella. Cut down to the bone, retract the flap, and cut the quadriceps above the patella. Insert a long knife at one angle of the wound, pass it back of the femur, and make it emerge at the opposite angle, cutting a posterior flap eight inches long. Retract the posterior flap, clear for sawing, and section the condyles horizontally. Carden made a curved section of the condyles at their widest part. In children Buchanan showed that we can easily separate the lower

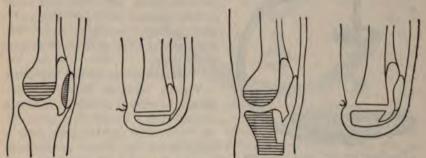


Fig. 873.—Diagrammatic representation of Gritti's operation.

Fig. 874.—Diagrammatic representation of Sabanejeff's operation.

femoral epiphysis. In Gritti's supracondyloid amputation an oblique incision is made. The upper end of the incision is posterior and just above the condyles. Its lower end is anterior and two finger-breadths below the patella (Kocher). The ligament of the patella is cut, the flap is turned up, the femur is sawn at the base of the condyles, the articular face of the patella is sawn off, and the sawn patella is fastened to the sawn femur and the flaps are sutured (Fig. 873). Sabanejeff makes an anterior flap, opens the kneejoint from behind, saws the condyles at their broadest part, takes a bone-flap from the anterior portion of the tibia and fastens it to the femur (Fig. 874).



Fig. 875. - Amputation of the thigh (Bryant).

Amputation of the Thigh.—
In high amputation in the lower third either a flap or a circular operation may be performed. In a double-flap operation a semilunar skin-incision should be made from without inward, and the muscles should be cut by transfixion (Fig. 875). In the lower third Teale's flap or the long anterior flap may be employed. The amputation by a long anterior flap consists in making a lengthy skin-flap, reflecting it, cutting the anterior structures to the bone, again

entering the long knife at one angle of the incision, pushing it back of the femur, bringing it out at the outer angle, and cutting the structures behind the bone directly backward. Bell amputates by a long anterior semilunar

flap and a short posterior flap. In amputations in the upper two-thirds of



Fig. 876. - Pancoast's aorta tourniquet.

the thigh the best plan is to mark out equal anterior and posterior semilunar skin-flaps, divide the skin with a scalpel, enter the long knife at one angle of the anterior flap, bring it out at the other angle, and cut the muscles by transfixion. Cut the posterior flap in the same manner. Some surgeons prefer a long anterior semilunar flap and a short posterior semilunar flap. The pure circular amputation is not adapted to the thigh.

Disarticulation at the Hip-joint.

—Various methods have been employed to prevent or limit hemorrhage during this formidable operation. Abernethy used digital compression of the external iliac artery or of the femoral artery. This is an extremely tiresome procedure; the finger is liable

to slip; and, in any case, compression so situated fails to intercept the blood-current in a number of large vessels.

Various other methods have been employed. It was formerly the custom to compress the aorta by means of an abdominal compressor (Figs. 876, 878). A tourniquet is very likely to be displaced during the operation. The intention is to compress the artery against the spine, but in effecting this the circulation in a portion of the intestine may be impaired. In any case, as Senn says, the circulation is cut off from half the body, and the patient is exposed to grave danger from "sudden vascular engorgement of important internal organs" (Senn). Again, an abdominal compressor of this sort does not arrest venous bleeding. A number of years ago Davy suggested that a suitable cylindrical piece of wood, about 25 inches long, and shaped like a cone at the end, might be introduced into the rectum and used to compress the common iliac artery upon the pelvic brim. This appliance is known as Davy's lever. It is apt to slip, and may do serious damage to the rectum.

Some surgeons have practised preliminary ligation of the common femoral artery or of the external iliac artery, and others have tied the vessels while making the flaps. I followed this

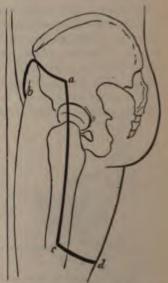


Fig. 877 —Posterior flap in author's unusual case requiring hip-joint amputation. a, b, The anterior incision a, c, d, the external incision and the beginning of the posterior cut.

plan with perfect satisfaction in a recent case of sarcoma of the femur with involvement of the iliac glands. If any form of compression is used, that recommended by Macewen, of Glasgow, is the most successful and satisfactory (Fig. 879). The weight of the assistant's body is thrown upon the patient's

aorta by the right fist, placed slightly to the left of the umbilicus. McBurney has suggested the prevention of bleeding by making a small abdominal incision and having an assistant make direct digital pressure upon the iliac artery. I em-



Fig. 878.-Von Esmarch's aorta tourniquet.

ployed McBurney's method in a recent case and found it most satisfactory. In this case a sarcoma of the thigh reached up so far that no band could be applied above it and I was obliged to make the posterior flap shown in Fig. 877. If the constricting band of Esmarch is applied by the



Fig. 879.—Macewen's method for compression of the abdominal aorta ("American Text-Book of Surgery").

ordinary method, it is certain to slip. It may remain in place if applied as a figure of eight of the thigh and the pelvis, but even then it is uncertain.

The most satisfactory method in the great majority of cases, is Wyeth's, in which the constrictor is held in place by the preliminary passage of two steel pins. Trendelenburg's method consisted in passing one pin and winding an elastic tube about it. Wyeth applied the principle and greatly improved the method. The outer pin is inserted an inch and a half below and a little internal to the anterior superior spine of the ilium, and is brought out just back of the great trochanter. The inner pin is entered one

inch below the level of the crotch and internal to the saphenous opening, and it emerges an inch and a half in front of the tuberosity of the ischium. A sterile cork is pushed on the end of each pin, to save the surgeon from wounding himself upon the sharp points. After the limb has been emptied of blood by

holding it in a vertical position for five minutes and stroking it from the periphery toward the body, the constricting band is fastened about the limb above the pins.

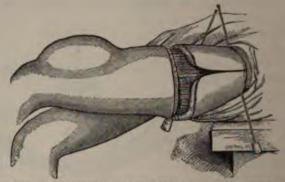


Fig. 880. - Amputation at the hip-joint-Wyeth's bloodless method.

In the bloodless method of Wyeth (Figs. 880, 881), after the passage of the pins and the application of the band of the Esmarch apparatus, the amputation is proceeded with. The hip is brought well over the edge



Fig. 881.—Wyeth's bloodless amputation at the hip-joint. Cuff of skin and subcutaneous is turned back, muscles divided at level of small trochanter, bone partly stripped, and large vessels as posed for deligation.

of the table, a circular incision is made down to the deep fascia, six inches below the constricting band, and is joined by a longitudinal skin-cut reaching from the band to the level of the circular incision, and the cuff is



Fig. 882.—Senn's method of performing bloodless amputation at the hip-joint. Dislocation of head of femur and upper portion of shaft through straight external incision. Elastic constrictors in place, the anterior one tied (Senn).



Fig. 883.-Elastic constriction completed by constricting the posterior segment of the thigh. Flaps formed, including all the tissues down to the muscles (Senn).

reflected to the level of the lesser trochante circular sweep at the level of the retracted consists opened freely, the cotyloid ligament is bent upward, forward, and inward to dislot and, using the thigh as a handle, the round light removed. After ligating the vessels and introduce are sewn together vertically. The old transport extinct. A T-amputation may be employed straight incision down to the bone, starting on the outer side of the limb, and a circular incise below the constricting band, the muscles being level of the retracted skin. This method at



Fig. 884.—Keen and DaCosta's case of interilio-abdominal amputation. The shaded portion of the bone was removed ("International Clinics," vol. iv, 13th series).

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this cannot be accomplished, the head of the bo dorsum of the ilium. After dislocating, the lapart of the femoral shaft are cleared. The lastraight line with the body, the thigh is slight of forceps is inserted into the wound behind the normal situation of the lesser trochanter, downward and inward, two inches below the behind the adductor muscles. As soon as the an incision two inches in length is made upon through the opening. The tunnel in the tiss forceps. A piece of rubber tubing three-quar four feet in length is caught about the middle

drawn. The rubber tube is cut in two at about the point at which the forceps have held it, and half of the tube is used to constrict the anterior segment of the thigh (Fig. 882) and the other half to constrict the remaining portion of the thigh (Fig. 883). Before the constricting bands are tied the limb is held vertically for a sufficient length of time to make it practically bloodless; the

amputation is then completed (Senn's "Practical Surgery").

Other Methods.- John G. Sheldon ("Amer. Med.," April 19, 1902) has modified Senn's method as follows: He disarticulates the head of the femur and frees the upper part of the femur from its attachments. He then introduces a pair of long, stout artery-forceps behind the femur and clamps the femoral vessels. He forms the flap, removes the limb, and ligates the vessels. In this operation the surgeon can work rapidly and can make a flap of any size or shape, and is not hindered by a constriction apparatus; but this

method does not cut off the bleeding from the obturator

and the sciatic arteries.

Larrey amputated by lateral flaps, and Liston by anteroposterior flaps. Forneaux Jordan's method consists in dividing the soft parts low down, tying the bloodvessels on the face of the stump, shelling out the femur

from the soft parts, and disarticulating.

Interilio-abdominal Amputation.—This very formidable operation is occasionally performed for sarcoma of the ilium. The operation was first performed by Billroth in 1891, and the patient died. Dr. Keen and I collected 10 cases, including 1 of our own. Five of these cases recovered (W. W. Keen and J. Chalmers DaCosta, in "International Clinics," vol. iv, 13th series). Our patient perished in thirty-three hours from suppression of urine and with gangrene of the parts supplied by the internal iliac artery. In some cases the entire innominate bone has been removed, in others portions



Fig. 885 .- Keer and DaCosta's method of interilio-abdominal amputation ("International Clinics," vol. iv 13th series).

of it have been left. In our case we made the flap shown in Fig. 885, tied the internal iliac artery after rolling up the peritoneum, but spared the external iliac, kept the femoral in the flap, and sawed through the bones as indicated in Fig. 884), leaving in place the portions shown in white.

## XXXVIII. DISEASES OF THE MAMMARY GLAND.

Hypertrophy of the Breast (Fig. 886).—This is a rare condition. It may affect one breast or both. It is most apt to appear at the age of puberty, but it may appear in childhood, adult life, or old age. The breast may attain enormous size. In Porter's case the breasts of a woman of thirty-seven were so very large that they were carried hung upon a frame ("Boston Med. and Surg. Jour.," March 3, 1892).

These very large breasts are not composed of true gland tissue, but rather of fat and connective tissue (Sheild). Hypertrophy may also occur in the male breast. In some cases hypertrophy occurs so rapidly as to merit the name

acute. Such cases may perhaps be sarcomatous.

Treatment.—Be sure it is hypertrophy and not sarcoma, adenoma, or lipoma. Try recumbent posture, dry diet, pressure, and iodid of potash (Sheild). If these means fail, amputation is the only resource.

Mammillitis and Fissure.—The nipple may inflame as a result of injury, but the condition is rarely encountered except in a woman who is nursing a baby. It is most common after a first pregnancy, when the nipple is deformed or when the skin is delicate. The nipple is slightly injured during nursing, and the epithelium is macerated by the milk and saliva. If the inflammation is not arrested, a spot excoriates or an irritable ulcer forms (a fissure). A fissure is often surrounded by an area of acute inflammation, and nursing causes intense agony. Because of the pain the mother is apt to



Fig. 886.-Hypertrophy of breast (Horwitz).

extend the intervals between nursing, and as a consequence the breasts become swollen with retained milk. The ulcer not unusually bleeds when the breast is taken by the child. Besides the facts that a fissure causes pain to the mother, it often leads to grave trouble. It is a suppurating area, and as such may lead to abscess of the mother's breast, or may impair the health of the nursing child.

Prevention of Fissure.

—During pregnancy the nipples should be carefully attended to. They should be washed often in sterile water and bathed in alcohol, and if retracted, ought to be drawn out repeatedly. During the period of lactation the nipples are washed in sterile water, dried, and dusted with borated talc powder as soon as

an act of nursing is completed. Washing the nipples regularly with the following solution tends to prevent the formation of a fissure: iodid of mercury, gr. ij; alcohol, 5iss; glycerin and distilled water, āā a pint (Lepage). If a small abrasion appears, order the woman to wear a nipple-shield during nursing, and after each act of nursing to wash the part with hot sterile water, dry, and dust borated talc over the surface. If a fissure forms, wean the child at once, and dry up the milk in both breasts. It is useless to try and dry it up in one breast. Milk may be dried up by applying ointment of belladonna locally, and administering iodid of potassium internally; by strapping the breasts with adhesive plaster (Parker); or by applying to the nipples six times a day a 5 per cent. solution of cocain in equal parts of glycerin and water (Joise). The fissure is not treated by ointments.

These preparations are septic, prevent drainage, and aggravate maceration. Wash the fissure twice a day with peroxid of hydrogen, dress it with gauze wet in boric-acid solution (gr. x to 3j of water), and cover the dressing with waxed paper. If the fissure resists treatment, touch it with lunar caustic.

Acute Mastitis and Abscess.—Acute inflammation of the breast, as a result of injury of the breast or nipple, may occur in either sex at any time of life. Very commonly in both sexes a few days after birth the breast becomes distended with a material which in reality is milk. The fluid is usually small in quantity. The process is physiological, and, as a rule, ceases spontaneously (Guelliot). If it lingers, the application of belladonna ointment will stop secretion. If the nurse meddles with and tries to squeeze out the fluid, acute mastitis is apt to arise in one gland, or occasionally in both. The skin of the breast reddens, the gland swells and becomes tender and painful, the child loses its appetite and becomes feverish, restless, and sleepless. Such a condition is treated by the local use of lead-water and laudanum. If pus forms, the local signs and constitutional symptoms are aggravated. Evacuate the pus, dress with hot antiseptic fomentations, and be sure that the child is well nourished. Tonics and stimulants are indicated.

A condition identical with the secretory activity of the glands of the newborn may occur in either sex at puberty. The methods of treatment are the same in both cases. As a matter of fact, rarely more than one lobule at this period inflames, and suppuration is most unusual.

Mastitis is most usually met with in a woman who is nursing a child, and is due to bacterial infection. Primipara are particularly liable to develop mastitis. So are women with deformed nipples. In many cases an abrasion of the nipple exists, and through this breach of continuity bacteria gain entrance to the breast-tissue. The abrasion may be so slight that it can only be detected when the nipple is examined through a magnifying-glass (Marmaduke Sheild). Streptococcic infections are very generally due to inoculation of a fissure of the nipple. Bacteria may pass up the milk-ducts, coagulating the milk and penetrating through the walls of the acini. Staphylococci not unusually pursue this route in reaching the breast-tissue. Occasionally causative bacteria reach the breast through the arteries (in septicemia and in septic wounds of the genital organs).

Symptoms.—There are pain, swelling, and tenderness in the breast, and in most cases a fissure or abrasion exists. There is a febrile condition. Occasionally a chill ushers in the attack.

Treatment.—Order the patient to suspend nursing. The physician endeavors to arrest the secretion of milk. Treat the nipple as advised on page 1420. Support the breast and apply ichthyol ointment or lead-water and laudanum.

Mastitis may undergo resolution; it may terminate in organization and induration; it may eventuate in suppuration.

Acute abscess of the breast follows acute mastitis. There may be but one area of suppuration, or multiple foci may exist, which eventually fuse. The symptoms of mastitis, local and constitutional, are greatly aggravated. After a time the skin becomes dusky and edematous. The axillary and superficial cervical glands enlarge. The abscess will eventually open spontaneously at one or more points, leaving branching fistulæ. A super-

ficial abscess is situated just beneath the nipple, and pus may flow from the

An intramammary abscess is in the depths of the gland. There are often multiple foci of suppuration. Nodules are felt in the gland, pus may run from the nipple, but cutaneous redness is late in appearing.

Retromammary abscess is a rather rare condition. It may occur alone or be associated and connected with an area of inframammary suppuration. It may result from metastasis or from caries of a rib. The breast is lifted up by the fluid beneath it.

Treatment.—Open a superficial abscess by an incision radiating from the nipple. Treat as any other acute abscess. An intramammary abscess should be opened by a radiating incision, and pockets of pus should be broken into with the finger. An examination is made to determine if a retromammary abscess also exists. If this is found to be the case, an incision is made at the point of junction of the thorax and mammary gland, and at the lower border of the gland. The gland is raised from the chest-wall, the pus evacuated, a drainage-tube is inserted, and a few sutures are introduced. If retromammary abscess exists alone, make the last-named incision in the first place.

Chronic Mastitis.—This condition may be present in only a portion of the breast, or may attack many lobules (lobular mastitis). The ordinary form may arise after weaning a child, or may be due to a blow, to the pressure of corsets, or to numerous slight traumatisms. It may occur in the young the middle aged, or the old. The patient has slight pain at times in the gland. Examination detects a firm, elastic area, which is somewhat tender and does not possess distinct margins. The skin is not adherent to the mass unless suppuration occurs. If the mass is pressed against the chest by the surgeon's fingers, it becomes evident that no real tumor exists.

Treatment.—Remove any cause of irritation. Support the breast in a sling. Apply ichthyol ointment. During the night employ a hot-water bag.

If pus forms, treat as before directed.

Chronic lobular mastitis is a condition in which numerous lobules become indurated. The real cause of this condition is unknown. It may occur at any age after puberty, and often attacks both breasts. Such a breast is apt to be painful, especially at the menstrual periods; it feels unnatural, solid, and careful examination detects numerous indurated areas, each of which is of small size. At the menstrual period the breast enlarges and new nodules may be detected. In some of these cases violent neuralgic pains are present in the gland (mastodynia). Chronic lobular mastitis is apt to lead to cyst-formation. When cysts form fluid may occasionally discharge from the nipple.

Treatment.—Support the breast and apply ichthyol ointment or belladonna ointment. Examine the generative organs and correct any existing abnormality. Improve the general health by good food, tonics, and open-air life. In cases where multiple cysts are known to exist the question of treatment is uncertain. There seems to be little doubt that such cases tend in some instances to eventuate in cancer. I believe that the proper treatment when multiple cysts exist is extirpation of the breast.

Tuberculosis of the Mammary Gland.—Sir Astley Cooper, in 1829, wrote on "scrofulous swellings" of the breast, and Velpeau also referred to

them. Nevertheless, Virchow in his treatise on tumors, stated that the mammary gland was not subject to tuberculosis. Durbar first proved the existence of the condition by histologic or bacteriologic observations. Primary tuberculosis of the breast is a rare condition. If we are to judge from English and American literature, it is a very rare condition, and only about 40 cases confirmed by bacteriologic findings and histologic study have been reported. It is seldom that both glands are involved. Tuberculosis of the breast may be secondary to tuberculosis of the skin, of related glands, of the rib, etc. It may result from some distant tuberculous lesion of bone, of joint, of lung, etc. It may be a part of general miliary tuberculosis. We consider here primary or, as Geissler named it, solitary tuberculosis, tuberculosis apparently limited to the breast in an individual free from evidences of antecedent tuberculosis. and of tuberculosis elsewhere. It occurs usually in those of excellent general health. The route of infection may be by the blood, by the lymph-ducts, and perhaps by the lymphatics from the skin or nipple. E. M. Von Eberts (in "Am. Jour. Med. Sciences," July, 1909) states that there is no reported case before the age of puberty, that the most advanced case reported was fifty-three years of age, that maturity of the gland and lactation predispose, and that the reported cases show the proportion of the married to the unmarried as 4 to 1. It is vastly more common in women than in men. In many cases there is a history of antecedent inflammation or abscess during lactation. In some cases there is a history of traumatism. There are two forms of the condition, and in each form, sooner or later, degeneration occurs, and fistulæ from a cold abscess arises (page 178); these forms are nodular and confluent (Von Eberts, Ibid.). In the nodular form a nodule, several nodules, or many nodules arise in the glandular tissue. There is little or no pain. If nodules are under the nipple retraction may occur. The condition is very slow in progress and a year or several years may elapse before degeneration occurs. Degeneration results in cold abscess (page 155) or fistula formation. Schley has pointed out that cold abscess is a termination more common in the confluent than in the nodular type ("Annals of Surgery," 1903). In the confluent form the condition develops much more rapidly, is associated with pain, is most apt to arise during lactation, is particularly prone to abscess and fistula formation, and is liable to acute exacerbation from secondary pyogenic infection. The axillary glands are found enlarged in three-fourths of all cases of primary tuberculosis. Cases have been reported of carcinoma and adenoma associated with tuberculosis.

Treatment.—In a very slowly developing nodular case, in which it is certain lactation will not arise, it may be considered proper to treat the condition with tuberculin, etc. (see chapter on Tuberculosis). In the confluent form and in cases of the nodular form in which tuberculin treatment has failed, or in which we cannot exclude the possibility of pregnancy, the breast should be removed and the glands and fat should be removed from the axilla. Most of the cases recover permanently after radical operation (see Braendle, of Tubingen, in Beit, Z. klin. Chir., 1906, Bd. 1).

Cysts and Tumors of the Nipple.—Tumors are rare in the nipple, but do sometimes occur. The following growths are occasionally seen: fibroma, angeioma, papilloma, myxoma, myoma, and epithelioma. Sebaceous cysts of the nipple and areola are not very unusual. A cancer of the nipple may be a primary growth, or may be secondary to gland cancer.

Primary epithelioma of the nipple presents the epithelioma in any other region. It begins as or an excoriation of the nipple. Ulceration so lar in outline, has hard edges, and furnishes discharge. The mammary gland becomes The subclavian glands enlarge, and later growth must not be confounded with a chancer

Treatment of Tumors of the Nipple.—Inn and the breast need not be removed.

Epithelioma of the nipple requires the con and also the clearing out of the lymphatic con of the subclavian triangle.

Paget's Disease of the Nipple (Mal dition is a chronic inflammation of the epit areola occurring in women beyond middle life, of epithelioma of the nipple and of duct cancer eczema, it is not associated with the usual ca either local or constitutional, and is not cur the ordinary disease.

The diseased area is raw and red, and from yellow discharge. In some cases Paget's disease auto-infection of the nipple having been effect the ducts. Investigations have shown the preson of Paget's disease.

Treatment consists in removal of the en the axilla.

Tumors and Cysts of the Mammar be innocent or malignant. Tumors may o sarcoma, fibro-adenoma). Malignant tumors twenty-five.

Innocent Tumors of the Mammary are: Periductal fibroma, fibrocystadenoma, adenoma, periductal fibromyxoma, myxoma, ang It is maintained by most authorities that an may and often does become malignant.

Periductal Fibroma, Fibro-adenoma.adenomata is in a state of great confusion. The
by Cornil and Ranvier to the same sort of gr
called a fibroma, Billroth an adenofibroma, at
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gland. A fibro-adenoma consists of acini
Each of these structures proliferates, but the fi
rapidly than the glandular. Bloodgood says
Feb., 1908) "the fibro-adenoma microscopic
encapsuled area of normal breast tissue, in whi
stage of the tumor, is greater in amount that
parenchyma undergoes pressure atrophy and
cified." A growth of this character is surround
It is firm, elastic, lobulated, superficially situa

unassociated with retracted nipple, glandular enlargement, adhesion to the skin, or cachexia, and may occur at any age up to fifty, but is most common between twenty and thirty (J. Bland Sutton). Such a tumor is rarely very painful, but it may be tender on rough handling and may be painful at the menstrual period. As a rule, there is but one of these tumors in a mammary gland, but the tumors may be multiple in one gland, or one may exist in each gland. It is not very common for sarcoma or carcinoma to arise.

Periductal Fibromyxoma.—It is most common in young women. It may be multiple in one breast or both. It is an encapsuled, lobulated, and elastic growth, which is seldom painful, usually small, and often remains quiescent indefinitely or even disappears. It may enlarge and even attain a large

size. When it enlarges it is apt to become cystic and sarcomatous.

Treatment of Periductal Fibroma or Fibro-adenoma.—Extirpation of the tumor. A tumor known to be innocent may be removed through an incision made along the junction of the mammary gland and breast, at the lower margin of the gland, as Thomas proposed, or, better, at the edge of the outer hemisphere, as advocated by Warren ("Annals of Surgery," June, 1907). The incision exposes the fibers of the great pectoral muscle, the gland is raised from the muscle, and its posterior surface exposed. Any growth is exposed by an incision from center to periphery and this incision is exploratory. Warren removes an innocent tumor, a cyst, or cysts by a V-shaped incision, the apex of the V being at the center of the gland, and he wisely insists that the tumor is not to be dissected out. Several radiating incisions may be necessary to explore a cystic breast. The V-shaped space from which the tumor or cyst was removed is closed by a double row of catgut sutures. Incisions for exploration seldom need to be closed with suture. The gland is sutured to the outer edge of the pectoral fascia, and a row of sutures is inserted through the deep layer of the superficial fascia. Warren calls this operation "plastic resection of the breast." It leaves the patient free from deformity.

Fibrocystadenoma or cystic adenoma (adenocele) is a rare form of slowly growing tumor, which is apt to attain a large size, which is nodular in outline, hard to the touch, and firmly attached to the mammary gland, but mobile upon the chest. A cystic adenoma has a distinct capsule. This form of tumor is painless, and is most apt to occur in women between thirty and forty who have borne children. The growth is adherent to the skin, but the cutaneous surface is not discolored, the cutaneous veins are not distended, the axillary glands are not enlarged, and the nipple is not retracted. From the walls of the dilated acini papillomatous growths are apt to arise (intra-

cystic vegetations).

Treatment.-Extirpation.

Papillary Cystadenoma.—This condition is often called villous papilloma or duct papilloma. There is much more epithelial proliferation than in the fibrocystadenoma, and the warty masses project into the cyst cavities. These growths are firm, grow slowly and painlessly, and seldom fluctuate. They do not adhere to the skin, attain a large size, or cause glandular enlargement. They are situated near or under the nipple, and occur particularly in middle life. Discharge of bloody fluid from the nipple is a common symptom.

Treatment.—Extirpation.

Simple Adenoma. This is a very rare tumor. It occurs in young and

middle-aged women. It is soft, nodular, and freely movable. It does not adhere to the skin and does not cause lymphatic involvement. It consists of glandular acini and a very delicate stroma of connective tissue. It tends to become cancerous.

Treatment .- Extirpation.

Myxoma is a rare tumor, and only occurs in a person of middle age. The growth is solitary, is soft, may be round or lobulated, and occasionally fungates. The nipple is not retracted, the superficial veins are not distended, and the axillary glands are not enlarged.

Treatment.—Removal of the mammary gland.

Angioma.—This form of tumor is very rare. It may arise secondarily to a nevus of the skin (Sutton). The diagnosis of angioma of the skin is readily made. In a cavernous angioma of the breast it will be found that the tumor can be lessened in size by pressure, and will be increased in size by coughing, laughing, and holding the breath. Pulsation may be detected and a bruit may be audible.

Treatment.—For treatment of nevus see page 361. If a cavernous angioma exists in the mammary gland, it will be necessary to extirpate the gland.

Lipoma and enchondroma occasionally occur in the breast.

Cysts of the Mammary Gland.—Involution cysts (cystic degeneration of the mamma) occur in women who are approaching the menopause. They occur earlier in those who are sterile than in those who have bome children, and may arise after chronic mastitis. The parenchyma of the gland undergoes atrophic change, but the ducts remain, become blocked and dilated. Numerous small cysts form, and both glands, as a rule, suffer. Villous growths may arise in the walls of the ducts. In some cases there is much white fibrous tissue between the cysts (cystic fibroma).

The subjects of this disease are often nervous, hysterical, and despondent.

One or more ill-defined indurations are detected. Frequently there is a history
of discharge from the nipple and of attacks of lancinating pain in the breast.

Cystic breasts are dangerous, because the intracystic vegetations are liable to
eventuate in duct cancer.

Treatment.—In such cases, after confirming the diagnosis by an exploratory incision, remove the entire breast (Snow).

Lacteal cyst (galactocele) is an accumulation of milk brought about by blocking of some of the milk-ducts. It arises soon after the delivery of the child, and grows rapidly. A large quantity of milk may collect, and rupture of the cyst-walls can occur, the fluid passing into the glandular connective tissue.

A galactocele is rounded, fluctuates distinctly, and increases in size during nursing. There is little or no pain. In some cases the contents of the cost coagulate and a solid mass is formed.

Treatment.-Incision and drainage.

Hydatid cysts are rare, but do occasionally occur. There are 33 positive cases on record (Le Conte, in "Amer. Jour. Med. Sciences," Sept., 1901). A small, hard, movable, and painless mass appears in the mammary gland. Usually it gradually increases in size, but it may grow rapidly for a time and then remain apparently almost stationary for a period. If rapid growth takes place there is always pain, and pain is usual in any case when the cyst

attains considerable size. Fluctuation is often absent and crepitation is never obtained (Le Conte). Suppuration is apt to occur and sinuses may form.

Treatment.—A small and recent cyst may be extirpated. If the cyst is not recent, but is fairly large and adherent, incise, evacuate, and pack with gauze. If the cyst is large and adherent, but is surrounded by considerable breast-tissue, partially amputate the breast (Le Conte). If the cyst is large and the breast practically destroyed, or if the nipple adheres to the cyst, remove the mammary gland (Le Conte).

Malignant tumors of the mammary gland are ten times more common than innocent tumors. We should regard every palpable tumor in the gland as malignant until it is proved to be innocent. In other words, we reverse the rule of jurisprudence. We regard every tumor as guilty of malignancy until its innocence is proved. If the mistake is made of regarding an innocent tumor as malignant, the woman loses her breast. If a malignant

tumor is regarded as innocent the woman loses her life.

Sarcoma.—Sarcoma of the mammary gland is a very rare growth (not over 3 per cent. of breast tumors). It may occur at any age from puberty to old age. It was long thought to be most common from twenty to thirty-five years of age, but Rodman's investigations show that one-half the cases occur in the fifth decade of life (Rodman on "Diseases of the Breast"). The growth may be composed of round cells or spindle cells; both varieties may be present, and myeloid cells may be found. Circumscribed sarcoma arises usually between the ages of twenty and thirty; it is firm to the touch, as it contains much fibrous tissue, is painless, does not grow very rapidly, glands are not involved, and there is no cachexia. The nipple is not retracted. The growth may adhere to the skin. It is composed of giant cells or spindle cells, and rarely returns after extirpation of the breast.

Diffused sarcoma is composed of small round cells, arises in the center of the breast, and grows with great rapidity. It is most commonly met with about the age of thirty-five, and a history of injury can often be elicited. The tumor is soft, some parts being softer than others because of cyst-formation. It is usually mobile upon the thorax, though it soon becomes adherent to the skin. The tumor reaches a very great size, and soon fungates through the skin. There is little or no pain. The cutaneous veins over the tumor are distended, the nipple is not retracted, and the axillary glands are not

often enlarged. Diffuse sarcoma is apt to recur after removal.

Treatment.—Remove the breast, and if the muscles of the chest-wall are infiltrated, remove them. The axillary glands should be removed whether or not they are enlarged. Operation will not cure when metastases exist. If the case is inoperable, we can try the use of Coley's fluid. If the toxins of erysipelas fail to arrest the progress of the disease, keep the patient as comfortable as possible by the administration of cocain and morphin.

Endothelioma.—This is a very rare tumor. I have had one case of it.

The diagnosis cannot be made from carcinoma.

Treatment.-As for cancer.

Carcinoma or Cancer of the Mammary Gland of the Female (Fig. 887).

—The great majority of mammary tumors belong to the genus carcinoma.

Cancer is due to proliferation of the epithelium of the acini (acinous cancer) or of the ducts (duct cancer).

Acinous cancer is vastly more common t is much connective tissue and but little pare cancer). In some cases there is little conr chyma (encephaloid or medullary cancer). parenchyma or stroma occurs, the growth is

Scirrhus, the common form of acinous ca On section it is concave, and Sutton says "re tumor is without a capsule, and the epithelia of fibrous tissue. Portions of tissue, even



Fig. 887.-Scirrhus carcinoma (J. C

tumor, contain foci of proliferating embryon or withering scirrhus the fibrous stroma contr fatty degeneration (Senn).

Halsted in 1898 described adenocarcinom in the direction of unrestrained epithelial produmer show the formation of tubular acini. resemble adenoma. Adenocarcinoma is no cancer. In the common forms the proliferation

blance to glandular structure, but multiplies irregularly in connective-tissue spaces or lymph-spaces.

Causes and Symptoms.—Scirrhus is more common among women who have borne children than among those who have not. Heredity is manifest in only about 10 per cent. of cases. The younger Gross found it in 1 case out of 9. Trauma has no apparent influence in producing cancer. The disease is rare before the age of thirty-five, and is most common between forty-five and fifty. The author operated for scirrhus of the breast on a woman only twenty-seven years of age. Henry saw a woman of twenty-one with cancer. It is frequently met with in the aged. These tumors are rare



Fig. 888.—Carcinoma of right breast. Lesion first noticed six months before photograph was made.

in the negro race. A hard nodule is found in the breast, usually under the nipple, but possibly far away from it. The growth is nodular, and is immobile from the beginning. In a large, fat breast there is often a deceptive sense of mobility, because some of the breast-tissue moves with the tumor. The cancer may have been present for a considerable time before being discovered. Sometimes wide-spread lesions develop from a small or an undiscovered breast cancer (pleural effusion, enlarged glands of the neck, disease of the spinal cord, bones of skull and brain). In obscure lesions of bones and viscera examine the mammary glands, because the trouble might be due to metastasis from an undiscovered carcinoma of the breast. What Osler calls mastitis carcinomata is a wide-spread regional metastasis, affecting one or both breasts and beyond them, and which attains a considerable size in a very few months. The breast soon becomes enormous and brawny, the skin is infiltrated, there are no nodules, the glands above the clavicle usually enlarge, and the arm may swell. Metastases may occur within the chest, either by lymph regurgitation from the axillary and subclavian glands, or directly through the chest walls to pleura and lung or to mediastinal glands. Retraction of the nipple is present in over one-half of the cases. It occurs when the growth is near the nipple, and is due to the contracting fibrous tissues of the tumor pulling on the milk-ducts. If the growth is far away from the nipple, a dimple is apt to form on the skin of the breast because of the pulling upon

the suspensory fibers.

Glandular enlargement in the axilla soon follows the appearance of a scirrhus; the glands become very hard and adherent. In over 60 per cent, of persons the glands of the axilla are felt to be enlarged when the patient first comes for treatment. Because the surgeon cannot feel enlarged glands is no proof that there are none. As a matter of fact, the glands are usually involved within two months of the beginning of the disease, but the involvement can rarely be detected externally until months later. Enlargement of



Fig. 889.—Recurrent carcinoma. Cancer en cuirasse.

the axillary glands is followed by enlargement of the glands in the posterior cervical triangle and in the mediastinum. Herbert Snow has shown that the blocking of the axillary glands often leads to regurgitation of lymph containing cancer-cells, the cells being thus deposited in the head of the humerus and the thymus gland. Cells in the thymus, after a time, cause a projection of the sternum (the sternal symptom). When the axillary lymphatics are extensively involved, the arm swells from obstruction to the lymph-flow (lymphedema) or pressure upon the vein. The tumor usually grows rather slowly unless lactation is established; then it grows rapidly. As it grows it infiltrates adjacent structures (the pectoral fascia, pectoral muscles, subcutaneous celular tissue, and skin). When the skin is destroyed, an ulcer forms, and around this ulcer the skin becomes red and filled with cancerous nodules, which feel

like shot in the skin. Metastases are apt to occur into the bones, liver, brain, pleura, spine, thymus gland, and rarely the eye.

Pain is usually present in scirrhous carcinoma. It is lancinating and neuralgic in character, and not brought on or increased by handling. It



Fig. 890.—Recurrent carcinoma of the breast.

ceases if colloid degeneration begins. The general health is usually unimpaired until ulceration takes place, when cachexia arises. The cancer en cuirasse of Velpeau is a condition in which the lymphatic vessels of the skin are extensively invaded, the growth itself being adherent to the wall of the



Fig. 801.-Ulcerating scirrhous carcinoma.

thorax. In this condition the chest-wall is fixed, respiration is difficult, and the temperature is commonly somewhat elevated.

In atrophic or withering scirrhus the contraction is so great that it seems as though the mammary gland had been removed. The duration of scirrhus, when left to run its course, varies, but the disease generally produces death within two and a half years. Occasionally it causes death within a year. In atrophic scirrhus the patient may live for many years.

Duct cancer is not a common growth. It arises from the duct-walls in conditions of cystic degeneration of the mammary gland. The tumor is softer than the acinous growth and is not nodular. There is no pain, no retraction of the nipple, no skin dimple. Serous or bloody fluid may often be squeezed from the nipple. A duct cancer grows and infiltrates less rapidly,

and involves adjacent glands later than does an acinous growth.

Cancer of the Male Breast.—This condition is seldom met with, though I believe it to be more common than is generally supposed. I have seen 3 cases within the last ten years. Each patient was in the early forties; neither complained of pain. In one, the breast had been extremely large from early years. In each case the growth was indurated, but in neither was there any retraction of the nipple. The condition in each patient was scirrhous carcinoma. Warfield has collected 32 cases from literature and has added 5 others ("Bull. of Johns Hopkins Hosp.," Oct., 1901). The patients were between forty and seventy years of age; 8 gave a history of injury; in 9 cases there was pain, and in 12 the nipple was retracted. Palermo has collected 750 cases of tumor of the male breast ("Semaine Médicale," May 20, 1908) and 649 of them were cancerous.

Treatment of Carcinoma of the Mammary Gland.—The treatment is early and thorough operation; the earlier and the more thorough, the better. The older surgeons operated simply to prolong life a few months; the modern surgeon operates with the hope of curing the patient. The mortality of the operation is surprisingly small. It is certainly under 2 per cent. Rodman's statistics (2133 operations performed since 1893 by twenty-one American surgeons) show a mortality of less than 1 per cent. I have personally lost 4 patients in over 200 operations. In 1878 Billroth's statistics showed only 8 cures in 143 cases. In 1896 W. Watson Cheyne reported 12 cures out of 21 cases (57 per cent.). His cases now show 54.8 per cent. alive and well from six to thirteen years after operation. Depage's statistics show that 48 per cent. of cases passed the three-year limit ("Presse Médicale," Oct. 21, 1908). Greenough, Simmons, and Burney consider 320 cases operated upon radically ("Annals of Surgery," July, 1907); 88 cases passed the three-year limit. Bloodgood ("Am. Jour. Med. Sciences," Feb., 1908) sets forth Halsted's statistics:

"The statistics in Halsted's clinic up to the present time show that among 210 cases, in which three years or more have passed since the operation, 42 per cent. are apparently well. If we consider the cases in which the axillary glands, studied microscopically, showed no evidence of metastasis, 61 cases, or 85 per cent., are well. In cases in which the axillary glands showed metastasis (110), 30 per cent. remained free from recurrence for three years. When the glands in the neck showed metastasis (40 cases), only 10 per cent. remained well for three years. In all of these groups metastasis has been observed after an interval of three years of apparent cure. Such late metastasis may take place up to eight years after operation. Excluding these cases of late recurrence, the definitely cured in these three groups is reduced to 75, 24, and 7 per cent. respectively, or, for all cases together, 35 per cent. I have not time to give the facts, but there is evidence to indicate that when the microscope fails to

demonstrate metastatic cancer cells in the lymphatic glands in the axilla, this is not a positive proof that metastasis has not taken place, and for this reason and others, which space prevents me from stating, there should be no restriction in the complete operation for carcinoma of the breast." It will be observed that of these 40 cases, with involvement of neck and axilla, only 4 passed the three-year limit. If they had not been operated upon, statistics would have been bettered. The surgeon who would not operate on such cases would have a higher percentage of cures for his statistics, but he would have sacrificed to statistical glory these 4 cases. If there is the slightest doubt of the diagnosis, make an exploratory incision before making the incisions for the removal of the breast (see Dawbarn's remarks on the deceptive signs given by thick-walled abscesses in the "Annals of Surgery," March, 1908). If the mass proves to be cancer, I always pack in a piece of gauze just wrung out of boiling water and go on at once with the removal of the breast. As Dawbarn shows, this method seals up the open mouths of lymphatics. A radical operation should remove the breast and much of the skin above it, the pectoral fascia, the pectoral muscles, the fat and glands of the axilla, and the fascia over the serratus magnus. As Chevne says, remove all the glands along the axillary vein and lift up the vein at the apex of the axilla and remove the glands and fat behind it. The sheath of the vein should always be removed. Cheyne points out that the line of spread must be traced upward along the vessels and nerves and downward along the external respiratory nerve of Bell ("Lancet," March 12, 1904). If three years after an operation there has been no return, we regard the case as cured (Volkmann's limit). As a matter of fact, recurrences are noted after five years, and this limit should be used instead of three years. It is true that 80 per cent. of those passing the three-year limit remain free from recurrence. Over 90 per cent. of those passing the five-year limit remain free. Coley reported 65 cases of recurrence-15 per cent. recurred after three years and 6 per cent. after fourteen years. Ransohoff collected 10 cases of recurrence during the seventh and eighth years, 2 each after the ninth, tenth, eleventh, twelfth, and fifteenth years, and 1 each after, at various intervals, from fifteen to twenty-five years. Martin suggests that these later so-called recurrences are really new growths in persons predisposed to cancer ("Annals of Surgery," Oct., 1908). Certain cases are unsuited for a radical operation: cases in which metastases exist; cases of cancer en cuirasse; cases where axillary involvement is very great. Chevne would also rule out cases where large glands may be felt above the clavicle, believing that in such cases the mediastinal glands must be cancerous.\*

Halsted's Operation.—Halsted performs a very radical operation. He removes suspected tissue in one piece, and thus prevents carcinoma cells falling into the wound, for it is well known that if such cells should fall into the wound they may grow just as may a graft of healthy epithelium. The neck, shoulder, the arm to the elbow, the entire surface of the chest down to the waist, both breasts, the axilla, the side and the back of the diseased side must be sterilized. It is necessary to have, besides scalpels and the ordinary instruments for an operation, a great number of hemostatic forceps (80 to 100). Place the patient recumbent, with a sand-pillow under the shoulder of the affected side. The shoulder is right at the edge of the bed, and a nurse holds

<sup>\*</sup>See "Objects and Limits of Operation for Cancer," by W. Watson Cheyne.

the arm from the side. Halsted describes his operation as follows:\* The skin-incision is made as shown in Fig. 862, and is carried at once through the fat. The triangular skin-flap (a, b, c) is turned down. The costal insertions of the great pectoral muscle and the muscle are split between the clavicle and

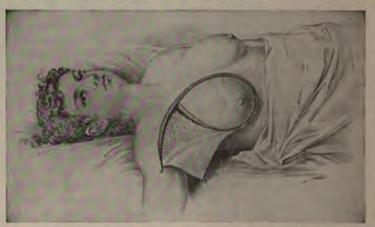


Fig. 892.—Halsted's operation for carcinoma of the breast; the first incision.

costal portions and up to a point opposite to the scalene tubercle, and at this point the clavicular portion of the muscle and the tissue overlying it are cut through close to the clavicle, and the apex of the axilla is at once exposed. The cellular tissue under the clavicular portion of the muscle is dissected from the muscle, and the splitting of the muscle is continued on to the humerus.

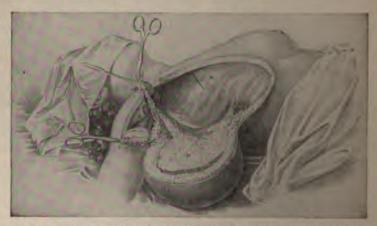


Fig. 893.—Halsted's operation for carcinoma of the breast; the mass turned down

The part of the muscle to be removed is cut through close to its humeral insertion. The whole mass circumscribed by the first incision (skin, breast, areolar tissue, and fat) is raised with considerable force in order to put the submuscular fascia on the stretch as it is stripped from the thorax close to the

<sup>\*</sup> Johns Hopkins Hosp. Reports, vol. iv; Annals of Surgery, Nov., 1894-

ribs. It is well to include the delicate sheath of the pectoralis minor muscle. The lower and outer boundary of the lesser pectoral having been passed and exposed, the muscle is cut at a right angle to its fibers and a little below the middle. The tissue over the pectoralis minor muscle near its coracoid insertion is divided as far out as possible, and is then reflected inward to prepare for the reflection upward of this part of the minor muscle. The upper portion of the minor muscle is retracted upward. Some surgeons do not remove the lesser pectoral muscle. I believe it should be removed, because the axilla can then be more easily and rapidly cleared. The removal of the muscle does not impair arm movements, and its retention leads to the formation, when healing is complete, of a cord-like band in front of the axilla. (See Douglas Drew, in "Brit. Med. Jour.," May 17, 1902.) The small blood-vessels under the minor muscle are carefully separated from it, are dissected out very clear, and are ligated close to the axillary vessels. Having exposed the subclavian vein at the highest possible point below the clavicle, the contents of the axilla are dissected away with a sharp knife and the vein and its branches are stripped absolutely clean. The loose tissue about the artery and the nerves should also be removed. When the vessels are cleared, the axillary

contents are rapidly stripped from the inner wall's of the axilla and the lateral wall of the thorax (Fig. 893). The fascia which binds the mass to the chest is cut close to the ribs and the serratus magnus muscle. Just before reaching the junction of the posterior and lateral walls of the axilla an assistant draws the triangular flap of skin outward in order to spread out the tissue which lies upon the subscapularis, teres major, and latissimus dorsi muscles. The operator cleans the posterior wall of the axilla from within outward. The subscapular vessels are clearly exposed, and are caught before they are cut. In some cases the subscapular nerves are removed, in others they are permitted to remain. Having passed these nerves, the mass is turned back into its normal position and severed from the body of the patient by a stroke of the knife from b to c, repeating the first cut through the skin. Every bleeding point, however small, is



Fig. 894.—The younger Senn's incision for amputation of the breast.

tied with fine silk. From 60 to 100 ligatures or even more may be required.

After the completion of the operation the wound into the axilla is closed with a subcuticular stitch of silver wire; if a cut has been carried above the

with a subcuticular stitch of silver wire; if a cut has been carried above the clavicle, it is closed in the same manner, and the edges of the elliptical opening are brought nearer together by a purse-string subcuticular stitch. Thiersch grafts cut from the patient's thigh are used to cover the gap. Silver-foil is placed over the wound, this is covered with gauze, bandages are applied, and the dressing is overlaid by a plaster-of-Paris bandage, which includes the head, neck, chest, and arm. The area from which grafts were taken is dressed with sterile gauze or an ointment containing boric acid.

Formerly I did not open the subclavian triangle. I believed that these

glands were involved only from the axillary lymphatics, that when they were involved the mediastinal glands were sure to be affected (the route to them being more direct) and operation was certain to be useless. When the subclavian glands are involved from the axillary lymphatics this is true, but in some cases they are involved by way of the direct lymph paths from the mammary gland. In such a case the mediastinal glands may be free, and cleaning out the subclavian triangle may save the patient. I always open the subclavian triangle and clear out fat and glands if no glands or only a few small glands were palpable before operation. If there is a large glandular mass in the triangle, operation is useless. I always open the triangle if the tumor of the mammary gland is in the upper hemisphere, or if I discover enlarged glands at the apex of the axilla, whether there are or are not small palpable glands above the clavicle.

The Younger Senn's Incision.—A very useful incision is that described by the younger Senn, and shown in Fig. 894. The breast is circumscribed by two curvilinear incisions which meet above, at the border of the great



for removal of the mammary gland.



Fig. 895.—Jabez N. Jackson's incision Fig. 896.—Method of approximating flaps after breast amputation.

pectoral muscle. The incision is continued a little internal to the outer border of the muscle to about 1 inch above the apex of the axilla, when it is curved outward in the deltoid region, and terminates at the level of the apex of the axilla. The breast is removed from the wall of the chest, and is then suspended by axillary glands and fat, which are removed en masse.\* This incision gives a free exposure, opens the axilla from in front, enables the surgeon quickly to locate and freely expose the axillary vein, and the resulting scar does not materially limit the motions of the arm.

Jackson's Incision (Jabez N. Jackson, "Jour Am. Med. Assoc.," March 5. 1906) is shown in Fig. 895. The axilla is entered from above, a quadrilateral flap of skin is raised, and is subsequently pulled down to and inclosing the wound (Fig. 806).

Warren's incision is shown in Fig. 807. It enables the surgeon to close the wound.

<sup>\*</sup>See the younger Senn in Jour. Amer. Med. Assoc., May 27, 1800.

Willy Meyer's Operation ("Jour. Amer. Med. Assoc.," July 29, 1905).— For the last three years I have been performing the operation devised by

Willy Meyer. I consider it a most excellent procedure, with distinct points of superiority over other plans. We owe to Gerster the principal of opening the axilla in the beginning of the operation in order to prevent the diffusion of cancer cells and so diminish the chance of rapid recurrence. Gerster's paper was published in the "American Jour. of Med. Sciences" in 1888. The younger Gross, in his later years, used to open the axilla first when there was an axillary mass, but he did it in order to determine in the beginning of the operation if the axillary mass was really removable. Willy Meyer emphasizes the value of his procedure in lessening hemorrhage. In Meyer's operation



Fig. 897.—Warren's incision for removal of the mammary gland.

two flaps are formed by the skin-incision (Fig. 898)—a lower and an upper flap. The incision for the formation of the lower flap begins at the point of insertion of the great pectoral muscle on the humerus, and is carried



Fig. 898.-Willy Meyer's operation for carcinoma of the breast. Skin incision as practised since 1898.

downward and inward ½ inch above the border of the muscle and parallel to it. When the incision reaches the base of the mammary gland, it

is carried along the lower margin of the gland, and it ends over the sternum, a little beyond the mid-line (Fig. 898). The lower flap is separated and turned down, a quantity of subcutaneous fat being allowed to remain attached to the breast. This turning down is carried to the border of the latissimus dorsi muscle, to the axillary cavity, and to the chest-wall. Meyer then directs that the border of the latissimus dorsi be followed down to the serratus anticus major, and upward to the mass of fat that enters the bicipital sulcus of the arm. The fat is removed from the anterior border of the muscle by blunt dissection. This anterior lower wound is then packed with gauze.

The surgeon next forms the upper flap by uniting the inner and outer ends of the first incision with another incision carried along the upper margin of the breast (Fig. 898). In this flap, as in the other, the surgeon leaves as



Fig. 899.—Willy Meyer's operation for carcinoma of the breast. Insertion of pectoralis major muscle exposed. Operator's left index-finger encircling its tendon.

much subcutaneous fat adhering to the breast as he can spare without inducing the danger of skin-necrosis. This upper flap is raised progressively until the cephalic vein is reached and there is exposure of the lower surface of the clavicle with the sternoclavicular articulation. Meyer directs that the tissues covering this articulation shall not be disturbed.

After the formation of these two flaps the next step in the operation is the division of the tendons of the two pectoral muscles and the exposure of the axillary and subclavian veins. Meyer advises that the cephalic vein be followed up until the insertion of the great pectoral muscle into the humerus is found. The tendon is fully exposed, care being taken to bare it of axillary

fat. The arm is then carried a little nearer to the side to relax the great pectoral muscle. This tendon is cut off close to the humerus (Fig. 899). The muscle is pulled downward and inward and is loosened from the cephalic vein. It is then cut off near the lower border of the clavicle and the sternoclavicular articulation. It is necessary to divide the nerves that enter the pectoral muscle, and all the vessels that come into view are divided between two clamps and tied.

The next step is to divide the tendon of the lesser pectoral muscle near the coracoid process (Fig. 900). Just beneath this tendon lies the subclavian vein. The surgeon now makes a transverse division of the fascia over the axilla, and thus exposes the axillary and subclavian veins (Fig. 901).

Meyer's third step is to split the axillary fat over the upper portion of the latissimus dorsi up to the axillary vein, "thus dividing it from the mass of fat that enters the sulcus bicipitalis brachii."

Next, the axillary and the subclavian veins are followed up to where the



Fig. 900.—Willy Meyer's operation for carcinoma of the breast. Finger under tendon of pectoralis minor muscle. Above, cut surface of clavicular portion of pectoralis major parallel to clavicle is visible (in the living, the belly of the pectoralis major is not so thoroughly detached from that of the pectoralis minor. It is done here to show the latter's tendon).

subclavian passes below the clavicle, and every vessel that evidently must be cut is divided between two ligatures and tied. This procedure saves a great amount of hemorrhage. Meyer directs us to be careful to preserve the two superior subscapular nerves, although the third subscapular must be sacrificed.

The next step in the operation is to have the assistant hold up the mass of partly loosened tissues without pulling upon them; for if he does pull upon them, Meyer truly says, he is apt to tear off pieces of periosteum or perichon-

drium; and such bare spots are liable to become necrotic. The surgeon now cuts to the wall of the chest, being careful not to damage the great serratus muscle. Meyer cautions us at this step to hold the blade of the knife horizontal; that is, "perpendicularly toward the thorax." "If he (the surgeon) should not thus turn the blade of his knife, but cut perpendicularly downward toward the subscapular muscle, he would enter the fat covering and enveloping the nerves and blood-vessels of this region, thus running the risk of unnecessarily causing considerable hemorrhage and of injuring the subscapular nerves. In the general run of cases this region need not be explored; only in very advanced cases did I find a few injected glands in this area."

The pectoralis major muscle is now divided close to the wall of the chest, the cuts being parallel to the ribs, and almost level with them; and the mass being gently drawn toward the sternum. By watching carefully, one may



Fig. 901.—Willy Meyer's operation for carcinoma of the breast. Subclavian and axillary via fully exposed. So far, glands and fat tissue not removed; smaller vessels still in connection with main trunks. Finger under fat toward sulcus bicipitalis, its nail resting on axillary vein.

see the perforating arteries and veins drawn out by traction before cutting them, and may usually catch each of them with two clamps and divide between the clamps. If this is impossible, they are divided and quickly picked up. The last tissue that holds the mass to the chest-wall is composed of the muscle-fibers from over the sternum. These are divided close to the sternum (Fig. 902). The final steps consist in tying all blood-vessels, draining, and suturing the wound. The draining is done through a perforation in the

posterior flap. It may be tubal or by gauze. Gauze has the advantage of restraining oozing of blood.

This operation has noteworthy merits. It can be performed far more rapidly than can any other method that I have ever employed. The loss of blood is comparatively trivial, because in this operation the chief bloodvessels are divided close to the axillary artery and tied. In removing the mass from the chest-wall there is little bleeding, except what comes from the perforating vessels, hemorrhage from the branches of the axillary being entirely absent; and even many of these perforating vessels are tied before being divided. We are far less apt by this method than by the usual plan to



Fig. 902.-Willy Meyer's operation for carcinoma of the breast. Pedicle of mass over sternum ready to be cut off.

milk lymph-containing cancer cells into the wound, or in aberrant directions through the lymphatics. As Dawbarn says, the squeezing "of the breast by the retractors during its oblation, as also its handling when separated, save for its attachments to the armpit," are real dangers and may be responsible for rapid recurrence of the growth ("Annals of Surgery," March, 1908). The drain is removed in from thirty-six to forty-eight hours. The patient is placed in a sitting posture on emerging from ether and is allowed out of bed on the fourth or fifth day.

Dressing and After-treatment.—The dressing must be wide and ample. Fluffed up gauze is pushed into the axilla to obliterate the dead space and the arm is bound to the side for forty-eight hours, when the binding is removed, the extremity is placed on a pillow, and is moved a little more each day. If

the incision was placed well above the axillary border the mobility of the arm will be such that in two weeks the patient can place the hand on the back of the head. Some surgeons place the arm at once after the operation in abduction (upon a pillow or a triangular splint which rests upon the side). This is unnecessary if the incision does not run into the arm and in front and above the anterior axillary margin. If the old incision in the axilla is made early, abduction and all other plans will fail to prevent limitation of movement.

Inoperable Malignant Diseases of the Breast.—This term implies that a radical operation looking to cure is impossible. The conditions in which it is impossible have already been specified (page 1432). Even if the case is judged inoperable from the radical standpoint, it may be wise to remove the mammary gland, in order to free the patient from a hideous, ulcer-

ating area, violent pain, and harassing hemorrhage.

It has been suggested that some cases inoperable by ordinary methods may be subjected to removal of the entire upper extremity or to disarticulation at the shoulder-joint with some prospect of cure. My own view, however, is that when a case has advanced so far that it is not amenable to ordinary operative treatment, neither of the above-mentioned procedures offers any reasonable chance of success. If the pain is extremely violent in an inoperable case, the surgeon may relieve it by dividing the brachial plexus, or perhaps by disarticulating at the shoulder-joint.

An inoperable case may be greatly improved—for a time, at least—by the use of the x-rays; and even when the condition is not benefited in other ways,

this new force sometimes mitigates or greatly relieves the pain.

Beatson's Operation, or Double Oöphorectomy.—It has been pointed out by this surgeon that there is a certain similarity between the formation of cancer in the mammary gland and the process of lactation. In each there is an enormous production of embryonal epithelial cells; but in lactation the epithelial cells undergo fatty degeneration, and in cancer-formation they do not do so, but penetrate into the tubules and the acini and infiltrate the glandstructure. Beatson further points out that when a lactating cow is spayed, it continues to give milk indefinitely. This seems to indicate that removing the ovaries favors the fatty degeneration of the epithelial cells. This operation has been performed in cases of inoperable carcinoma of the breast, in the hope of bringing about degeneration in the tumor-mass. In the great majority of cases it fails utterly; but now and then it secures a notable improvement, and in a very few cases cure seems to have been obtained. Abbe obtained an apparent cure in two patients. It was at first thought that the operation would be applicable only to persons that have not passed the menopause, but one of Abbe's patients was over seventy years of age. Butlin, however, says that there is no genuine cure secured by this operation on record. My own view is that the procedure offers but little prospect of success, but that, as it does offer some, the exact facts should be placed before the patient, and she should be permitted to choose whether or not she wishes the operation performed. The operation is not to be considered, however, if visceral deposits exist.

## XXXIX. SKIAGRAPHY OR RÖNTGENOGRAPHY (THE EM-PLOYMENT OF THE X-RAYS). THE FINSEN LIGHT; BECQUEREL'S RAYS; RADIUM RAYS.

The Röntgen or x-Rays.—The cathode rays were discovered by Hittorf, in 1869, while passing an induction current through a vacuum tube. Crookes, of London, greatly improved the vacuum tube, and obtained a rarefaction which left in the tube but one-millionth of an atmosphere. This last-named observer found that when an interrupted current of high potential is passed through a vacuum which is nearly perfect, fluorescence takes place. In a Crookes tube the positive electrode is placed at some indifferent point, and the current from the negative electrode flows not to the positive, but directly to the wall of the tube opposite the cathode, and at this point the phosphorescent glow is detected.

In 1895 Röntgen, of Würzl urg, while making a study of cathode rays as developed in Crookes tubes, discovered the energy which he named the x-rays. Röntgen showed that at the wall of the Crookes tube opposite the negative electrode a new and hitherto unknown energy is generated. Because of the uncertain character of this energy he gave to its manifestation the

name of the x-rays or unknown rays.

The x-rays are invisible; cannot be deflected, refracted, or concentrated; are not influenced by the magnet, and produce none of the ordinarily recognized effects of heat. The rays cannot be polarized, travel with the velocity of light, and cause fluorescence in certain substances, notably in the tungstate of calcium (Edison), platinocyanid of barium (Röntgen), and the platinocyanid of potassium. They have a marvellous power of penetration. Freund says ("Radium Therapy"), "Speaking broadly one may say that the lighter the specific gravity of a body the more transparent is it to x-rays. On the other hand, a body's opacity for the rays increases with its density, though not in the same proportion." "V. Novak and O. Sule, also Voller and Walter, proved that the transparency of a body to x-rays depends less upon its density than upon its atomic weight."

The x-rays in their action on photographic plates or films exhibit actinic effects. If, therefore, an object whose component parts are of unequal density—e. g., the hand—is placed on a photographic plate protected from ordinary light, and exposed to the action of x-rays, the plate when developed by photographic methods will exhibit a picture of the shadows cast by the several parts of the object. Such a picture is known as a skiagraph, radiograph, or a Röntgenograph. Similar shadows will be seen on a fluorescent screen if the object is between an excited x-ray tube and the screen. The portion of the screen free from shadow glows with fluorescence. Such a screen is known as a fluoroscope or Röntgenoscope.

The real nature of the rays remains unknown. They resemble the ultraviolet and Becquerel rays in their action on a charged electroscope and in producing fluorescence in certain substances, but the latter have not the penetrating power of the former. Many theories have been advanced, but the most acceptable has been on the electromagnetic theory of light. The difference

between the Röntgen rays and a beam of sodium light is said to be that the thickness of the Röntgen ray pulse is very small compared with the wave length of sodium light, and that in the Röntgen rays there is not that regular periodic character which occurs in a train of waves of constant wave length (J. J. Thompson).

Solid bodies which are struck by the x-rays emit new rays having similar properties (Sagnac), known as secondary rays, and less powerful than the primary rays.

For practical purposes we may consider that the x-rays have penetrating

and actinic properties.

For the production of the Röntgen rays the essential is to have an electric current pass through a Crookes tube of rather high vacuum. The state or degree of vacuum controls the nature of the rays. A tube of low vacuum will emit soft rays of low penetrating power, while the rays from a tube of high vacuum will penetrate even pure sheet lead. The vacuum of a given tube does not remain constant with use, the tendency being for the vacuum to become higher. Some get so high that they cannot be used. All modern tubes have some device by means of which the vacuum may be regulated and controlled.

The soft rays are rich in actinic value, but because of their feeble penetrating qualities are of use only in treating superficial conditions, or for the Röntgenography of thin parts, and where much contrast of shadows is desired. On the other hand, in deep and dense parts satisfactory results can only be obtained with hard rays. In the hands of the experienced operator the quality

of the rays is adapted to the condition.

To excite the Crookes tube or, as it is more commonly called, the x-ray tube it is necessary to have an electric apparatus capable of delivering a current of high tension and as far as possible unidirectional. Röntgen used the induction-coil of Ruhmkorff. The fundamental parts of an induction-coil are a primary winding, which receives and stores up the electricity from its origin or from its source of supply, an interrupter, to make and break the current, and a secondary winding, which receives the current and delivers it to a negative and a positive pole. Wires carried from these poles to their respective terminals on the x-ray tube will complete the circuit.

A static machine is frequently used to excite Crookes tubes, but only the most powerful are of practical value in x-ray work. The most recent and powerful apparatus is the Röntgen transformer, invented by Snook, of Philadelphia. The first machine of this type was installed in Jefferson Hospital in June, 1907, and this type is now internationally accepted as the best Many of the German firms are making a more or less exact copy of the Snook apparatus. This apparatus is an epoch-making advance in the construction of the Röntgen transformer.

The induction-coil is the most widely used apparatus, but it possesses many disadvantages, the chief of which is that its output is not constantly unidirectional. The static machine delivers a current of ideal quality, but one lacking in quantity. The Röntgen transformer has none of the disadvantages of the induction-coil, is capable of an enormous output of a current free from inverse discharge, and in quality approaching that of the static current. The most satisfactory source of current is the ordinary electric-lighting circuit.

Physiologic Effects of the Röntgen Rays.—Clinical observations have determined that in small or moderate intensity the Röntgen rays act as a stimulant to cell-growth and metabolism, while prolonged radiation produces cell destruction.

Histologic study shows that the cellular elements of the integument are first affected, and that only after repeated or prolonged exposures are the normal connective-tissue elements acted upon noticeably.

Cell degeneration occurs and is followed by inflammatory changes in the surrounding tissues, notably in the blood-vessels.

After sufficient irradiation this process will go on to endarteritis and necrosis.

The cause of these tissue changes under x-ray exposure has been variously conjectured, viz.: liberation of ozone in the tissues (Tesla); interference with cellular nutrition caused by static electric currents "induced by the introduction of the patient's tissues into the high potential induction-field surrounding the tube" (Leonard); the destruction of the nerve supply of the tissue (Hopkins); irritation of the peripheral extremities of the sensory nerves, causing vasomotor paralysis (Rudis-Jicinsky); "no doubt there is some chemic action which causes metabolic disturbances" (Beck); "the effects of x-rays upon tissues and upon substances sensitive to x-rays are due to actinic properties of the same character as those of light" (Pusey).

It is now generally admitted that the rays themselves are responsible for the tissue changes, and not some external agent, such as electric discharges.

The earliest noticeable effect of exposure to x-rays is a tanning of the skin in dark people or reddening of the skin in blondes. Ormsby has noted this analogy between the action of x-rays and the sun rays.

Glandular structures undergo atrophic changes after repeated exposures. Its action on the nervous mechanism is more difficult to understand, but that it has anodyne effects in certain painful conditions is beyond question. There is also testimony, but not certain evidence, that the x-rays have an inhibitory influence on the sympathetic nervous system. It has occurred that a small ureteral calculus, lodged in the lower end of one ureter for a long period, has passed into the bladder within a few days after x-ray examination.

The influence of Röntgen rays is in many cases distinctly inhibitory to the growth of bacteria.

The untoward effects from overexposure to the x-rays may range from falling out of the hair or slight irritation of the skin to the production of sterility, extensive sloughing or even chronic non-healing and painful ulcers, cancer, and death. These affects may be acute or chronic. The patient is more apt to develop acute conditions, while the operator or investigator is constantly in danger of the remote or chronic lesions.

The so-called x-ray burn is not a burn, but a dermatitis or a gangrenous process. A burn results from heat, begins on the surface and at once, is accompanied by pain from the moment of its origin, and is followed by inflammation starting from the surface burnt. An x-ray burn does not come in evidence for several days or for a longer time after the application of the cause, and the inflammation begins in the skin rather than upon its surface. So called x-ray burns may be classified by stages or degrees. In a burn of the first degree the skin is hyperemic, more or less tender, and may itch or burn,

there is increased pigment formation and the outer layer of the skin will "pull off" as in sunburn. It may develop any time after a few days, but usually does so in from ten to twenty. Such a condition is popularly known as a "reaction." No treatment-is required for dermatitis of this degree, unless there is severe itching or burning, when we may use the following preparation advised by Dr. Martin F. Engman ("Interstate Med. Jour.," July, 1903): It consists of 12 drams of boric acid, 1 ounce of zinc oxid, 1 ounce of starch, 1 ounce of subnitrate of bismuth, 1 ounce of olive oil, 3 ounces of lime-water, 3 ounces of lanolin, and 12 drams of rose-water. The powder is rubbed in a mortar, the lanolin is added. The olive oil and lime-water, mixed, are slowly added to the powder and lanolin. The mixture is stirred, the rose-water is added, and the preparation is beaten into a creamy paste. If itching is severe, 1 to 2 per cent. of carbolic acid is added. The paste is spread on several thicknesses of gauze and the gauze is covered with a rubber dam.

In an "x-ray burn" of the second degree the condition becomes more painful, vesicles or even bulke are formed, there is swelling, and if the blisters are opened the denuded cutis will weep and is sensitive to touch and to direct contact with air.

This condition requires little treatment beyond aseptic attention and

protection from further exposure to x-ray or air.

The "x-ray burn" of the third degree involves all the layers of the skin and more or less of the underlying tissue. In an area of sloughing the slough is white, adherent, tough, and stringy. Hopkins calls the process "white gangrene" (G. G. Hopkins, "Phila. Med. Jour.," Jan. 6, 1900). The pain is excruciating and constant, seeming as if "red-hot coals were held against the body." Sloughing may continue for weeks or months, and the exudate is profuse and irritating. The process may eventuate in gangrene of a limb or large area. Such ulcers require months to heal, if they heal at all, and are not improved by the treatment which relieves ordinary burns. Excision with subsequent skin-grafting or amputation may be necessary. In the early stages alkaline astringents give the best results, e. g., a mixture composed of 2 drams each of zinc oxid and bismuth subnitrate, ½ fluidram each of liquor potassa and liquor plumbi subacetatis, 2 drams of glycerin, and sufficient lime-water to make 6 fluidounces.

This mixture may be applied twice daily and will relieve much of the itching and burning as well as control the exudate. It should be applied over a considerable area surrounding the seat of inflammation. Ointments should not be used to relieve pain. Leonard considers them conducive to malignant changes

In extensive ulceration the wound must be kept as clean as possible and free from irritants. When sloughing ceases and granulation tissue forms,

mild stimulants may be applied.

The patient's general health should be improved in every possible manner. Skin-grafting is not usually successful without excision of the floor of the ulcer, but should be tried. In spite of all treatment the condition may remain a chronic ulcer and be subject to malignant change.

Sometimes the results of an  $\alpha$ -ray burn may be most serious. In a case reported by J. P. Tuttle it became necessary to amputate the thigh ("Med.

Record," May 5, 1898).

The chronic "x-ray burn" or chronic x-ray dermatitis is seen among operators or men working more or less constantly with the rays. The onset is very insidious. Ulcers may not form for a year or more. The earliest signs of trouble are brittleness of the finger-nails and itching about the matrices. Scratches on the fingers heal sluggishly. The skin atrophies, telangiectases form, vesicles appear and disappear, keratoses develop, fall off, and return. Small ulcers start and gradually heal, reappear, become more extensive, painful, and sluggish. The finger-nails drop off, leave sensitive surfaces, and grow again indifferently or in a misshapen condition.

If exposure is continued the ulceration advances, and the tendons and even phalanges may slough away. Usually when ulceration of this kind has started, the damage is irreparable except through amputation or excision, with, of course, absolute protection from further exposure.

These lesions are most common on the hands, but may occur elsewhere.

That malignant changes take place in chronic x-ray lesions has been definitely shown clinically and by the microscope. Porter, of Boston, has made an extensive study of these lesions, and emphasizes the importance either of excision and skin-grafting or amputation as methods of treatment.

His results are excellent. Palliative treatment should be limited to cleanliness and care.

Sterilization of either sex by use of the x-ray is possible and should be guarded against.

Can the x-rays cause death? The x-rays do not cause death directly, but may inaugurate a lesion which eventually causes death. Death may follow a burn without being directly due to it. Carcinomata have developed in chronic x-ray lesions and produced death; 4 fatal cases have been reported in the United States from multiple carcinomata following chronic x-ray dermatitis (C. A. Porter and C. J. White, paper before the American Surg. Assoc. in 1907).

Unnecessary exposure to x-rays is to be avoided. The operator should remain as far away from the excited tube as possible, and have between it and him a lead screen no less than \(\frac{1}{4}\) inch in thickness and of dimensions sufficient to protect his entire person. The patient is to be protected from undue irradiation by means of lead-glass or lead-covered tube-holders and lead diaphragms. In the treatment of lesions beneath the skin some form of filter should be used over the exposed area. Sheet aluminium is commonly used. Pfahler has suggested the use of sole leather.

The function of the filter is to absorb the soft rays, which would be otherwise taken up by the skin and would irritate that structure. With proper care patients may be treated safely and frequently over a long period of time.

The Uses of the Röntgen Rays.—In the hands of trained and experienced workers this agent is a most valuable aid in nearly all branches of medicine and surgery; whereas, in the hands of the untaught and inexperienced, it may lead to grave error in diagnosis, and is, even at the present day, fraught with all the dangers of its early use. The general practitioner should not attempt its use without first having had practical training.

For diagnostic purposes studies may be made by means of the *fluoro-scope* or by making Röntgenographs (skiagraphs, radiographs).

Edison's fluoroscope consists of four sides of a box, one end being open and

made to fit tightly over the observer's eyes, the other end being closed with cardboard made fluorescent by smearing it with mucilage, and before the mucilage is quite dry sprinkling it with crystals of tungstate of calcium. If it is desired to examine the hand with a fluoroscope, the extremity is held opposite an excited Crookes tube and from 6 to 10 inches away from it; the end of the fluoroscope, which is covered with fluorescent paper, is placed near the surface of the hand which is away from the tube, and the observer looks through the other end of the instrument. The flesh seems but a dim haze, and the shadows of the bones are distinctly outlined. The fluoroscope is of advantage in the examination of the movable organs of the chest and abdomen. This method, except with special forms of apparatus, endangers both the patient and operator. It was used extensively in the pioneer days and caused the vast majority of injuries to the early workers.

Röntgenographic technic has been wonderfully developed in the last few years. This method has the advantage of safety to patient and operator, as well as permanency of record. With the most improved apparatus a Röntgenograph of any portion of an averaged sized person can easily be made with an exposure of five seconds or less, so that the motion of breathing need not interfere as it did in former years. Children are skiagraphed by instantaneous exposure and seldom require an anesthetic. It is the most valuable agent we have for the study of bone conditions. In fractures the rays enable us to determine the nature of the injury, the amount of splintering, the existence of impaction, the question whether or not the fragments are in contact or can be brought in contact, the direction of the line of fracture, the variety of deformity, the existence of more than one fracture, the presence of epiphyseal separation or dislocation alone or with a fracture, the existence of an ununited fracture, the presence of callus, and if the splints are holding the fragments in apposition. By means of stereoscopic Röntgenographs fractures of any part of the skull can be detected; and the actual relations of the parts in fracture or dislocation of the hip, pelvis, or shoulder can be determined.

Fractures of the spine in the lower dorsal region are difficult to demonstrate in stout persons. In bone disease the experienced Röntgenologist can greatly aid the surgeon in making a differential diagnosis. The dissolved appearance of the bone in myeloid sarcoma without evidence of demarcation differs from the tuberculous bone, which presents a picture of impoverishment of mineral matter, but with more or less distinctly outlined foci of destruction. Bone atrophy due to pressure or disuse presents still another picture. Chronic periostitis, osteoperiostitis, necrosis, chronic osteomyelitis, and osteosclerosis cast shadows more or less characteristic. Bone-cysts, giant-cell sarcoma, osteoma, and osteophytes show clearly. Conditions about the joints, such as arthritis deformans, ossifying bursitis, and foreign substances within the joints, the character of deformity and whether due to disease or congenital defect can be determined. The bone changes of rickets and scurvy appear in distinguishable manner.

Pathologic processes in the accessory sinuses of the skull and in the mastoid cells are capable of detection, and the condition as well as position of the teeth can be shown with great clearness.

Intrathoracic conditions from very early tuberculous deposit in the lungs to generalized involvement; thickened pleura; extensive effusion; cavity formation; consolidation, the excursus and relations of the diaphragm (Williams' sign) to fixation of this organ; from the normal heart to all sorts of variations in size, shape, and position; dilated aorta; aneurysm; the presence of enlarged mediastinal or peribronchial glands; and tumors of this region, can be studied to great advantage in connection with physical and clinical findings.

Through the painstaking and untiring efforts largely of Rieder, Holz-knecht, and Jonas abroad, and of Hulst, Pfahler, and Leonard in America much has been made practical in the diagnosis of disease of the alimentary canal. By means of the technic they have developed the Röntgenologist can demonstrate constriction, dilatation, diverticulum, and often tumors involving the esophagus; the size, position, shape, motor activity of the stomach; hourglass contraction, invasion in the walls by irregular indentations of malignant growths, often the probe-like opening through a pyloric stenosis, and occasionally the presence of ulcer of the stomach. We can determine the character of peristaltic function in the small intestine or obstruction of the small intestine, and in addition, the presence or absence of ptosis, dilatation, or contraction of the large intestine.

In a study of the urinary organs the Röntgenologist should be able to determine the size and position of the kidneys in a normal subject weighing 160 pounds or less. In larger persons only the best skiagraphs will show the outline of the kidneys. In patients under 160 pounds renal calculi from the size of a No. 2 shot to the largest found, whether single or multiple, in one kidney or both, and relatively their situation in the kidneys (except in stones composed of pure uric acid) can be determined in Röntgenographs of the best quality. One can frequently aid in the diagnosis of movable kidney, tuberculosis of the kidney, advanced pyelitis and pyonephrosis or hydronephrosis, although in these conditions the x-ray evidence is purely corroborative of other clinical findings. Ureteral calculi are subject to the same display as renal calculi. The course of the ureters can be shown clearly if ureteral catheters styleted with fine fuse wire are passed from the bladder to the kidney. This is of value when in the region of the lower end of the ureters there appears a shadow of a foreign body which may be cast by a ureteral calculus, a small deposit of bone in some of the pelvic ligaments, a phlebolith, calcareous gland, an appendolith, or, in the female, calcareous deposits in the mucous membrane of the vagina or in the tubes. The ureteral stone is never round; it is oval or irregularly oblong. In the portion of the ureter overlying the sacroiliac joint it is possible that even a small phosphatic or oxalate stone may escape detection. In doubtful cases the ureters should be catheterized. Stone in the bladder is usually well shown, but here one is more apt to encounter pure uric acid calculi. The Röntgen method is particularly valuable in disclosing the presence of a stone encysted in the mucous membrane of the bladder, or when, because of disease of the prostate, instrumentation is very painful or contraindicated. The Röntgenologist should never say that a stone does not exist, especially in the bladder. An absolutely necessary procedure, prior to study of the urinary organs, is to have the patient thoroughly purged and the stomach empty. The stomach usually lies over the left kidney, the hepatic flexure of the colon overlies the region of the right kidney, and the ureters are throughout their course in a position to be obscured by intestinal contents. Hardened feces in the rectum may be mistaken for vesical calculi. The liver and spleen offer but little field for useful study. Enlargement may be seen. Biliary calculi are not often seen in the x-ray negative, because they are lacking in density and are surrounded by thick structures. One cannot make a negative diagnosis of biliary calculus by means of the x-ray. Chronic discharging sinuses may be outlined and studied after they have been injected with bismuth paste. This study is best made by means of stereoscopic negatives. In advanced atheroma the outlines of the arteries of the extremities are seen in the Röntgenograph.

Localization of Foreign Bodies.—Metallic bodies, such as bullets, pieces of steel or iron, coins, pins, needles, tin, zinc, brass, etc., can be detected in any portion of the body and accurately localized. Fragments of stone, granite, marble, and lead-glass can be skiagraphed except when very small and deeply situated. Drainage-tubes and iodoform gauze can be found if lost in a sinus or cavity. Anthracite coal, glass other than lead-glass, or splinters of wood are



Fig. 903.—Gunshot-wound of the lung. Rib resection for secondary hemorrhage into the pleural sac ten days after the injury; bullet not removed. Hemorrhage arrested by packing with gauze. Skiagraph taken three months afterward shows the bullet (author's case).

difficult to detect unless they are of considerable thickness, are not superimposed by bone, and are imbedded in thin structures so that the foreign body can be brought close to the sensitive plate. When the fingers are the seat of injury, anteroposterior and lateral views are sufficient. When in the esophagus, trachea, or bronchi the fluoroscope should be used for differentiation, after which a skiagraph will assist.

Foreign bodies elsewhere should be localized, either by stereoscopic Röntgenographs if near a joint or in close relation to some bony surgical guide. (See stereoscopic skiagraph, Fig. 904, of bullet in a shoulder case of mine, where the bullet lay in close relation to the anterior surface of the glenoid process, and on a line perpendicularly below the coracoid process. This bullet was removed with ease.)

Pieces of needle in the palm of the hand or soft parts near the surface are best localized stereoscopically when a definite relation between some known surface mark and the foreign body can be determined. A thin coating of bismuth on the palm of the hand will cause every line in the skin to show on the skiagraph. When the foreign body is deeply situated and not in close relation to a surgical guide, some method of localization must be used to indicate the depth and direction from a known point on the surface in which the body lies. All localizing methods are based upon displacement of the foreign body shadow by making two or more exposures with the x-ray tube in different and known positions, while the part containing the foreign body and sensitive plate remain in one position. This has been called the triangulation method.

Mackenzie-Davidson first used the cross-threads, from the known positions of the focus point of the x-ray tube to their respective shadows on the negative, the crossing of the threads representing the position of the foreign body in relation to the sensitive plate and focus tube. Measurements were then made

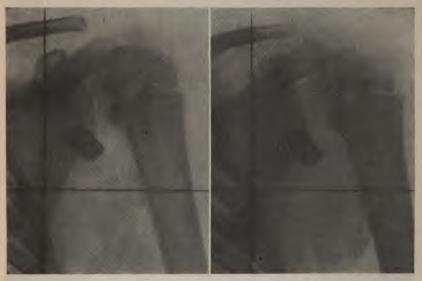


Fig. 904.—Bullet localized by means of stereoscope. Removed.

from some point on the skin of the patient that had registered with a known position on the negative. The Röntgenologist could then say that the foreign body lay perpendicularly beneath a certain point to a definite depth. Nearly all the modern localizing schemes are modifications of this general plan, and differ mainly in the manner of determining the position of the focus point of the x-ray tube.

A foreign body, unless it be large, may easily lie to one side of an imaginary line as drawn by the scalpel to the depth of 2 or more inches; again a change in position of the patient will alter the relation of the foreign body to a perpendicular line from the indicated surface point. A modification of the Mackenzie-Davidson scheme was devised by Snook. Manges improved the apparatus by limiting the possibility of error, and in using it as a guide during the surgical operation. With this apparatus all relations between the patient, foreign body, source of x-rays, and sensitive

plate are obtained, maintained, and regaine

curacy.

The localizer is a detachable part of the ographic table, and consists of a metal frame he near their top by a horizontal bar and at the upper bar is deeply notched to a scale of it. To the curved bar are attached four adjustable are used to establish a relation between the lot to indicate the depth and direction of the for the desired depth by a collar and set-screw a of the tube carriage is graduated on one side

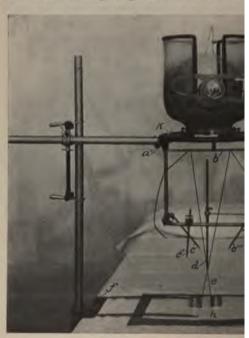


Fig. 905.-Modified Mackenzie-I

on the cross-bar of the localizer. The focus (the source of the rays) is accurately determ on one side of the lead-glass tube shield to c shield, and is exactly 6 inches above the level izer. The relation between the focus point a by means of a clamp on the edge of the table. arms projecting over the sensitive plate and a f the upright bar of the carriage rests.

In making the localization the patient is plate operation. A sensitive plate, 10×12 or 11×14 the foreign body, the tube clamp applied, a and tube are adjusted and leveled. Three of

izer are made to touch the surface of the patient at as widely separated points as possible, in which positions they are tightly clamped. These three spots are touched with silver nitrate.

After all adjustments are examined, and the height of the tube from the plate noted, the carriage cross-bar is elevated and the localizer removed. By lowering the tube-carrier to 6 inches below its original position, the focus point of the tube will be at the level formerly occupied by the cross-bar of the localizer, and if the carriage cross-bar is shifted to a definite distance to one side of zero, the focus-point will be in the corresponding position held before by a notch on the cross-bar of the localizer. After carefully adjusting the tube-holder an exposure is made. The carriage is then shifted to the opposite side



Fig. 906.—Bullet localized by method described in the text. Removed.

of zero in the same extent and manner, and a second exposure made. The patient is removed, the plate developed, and tracings of the shadows of the foreign body and arms of the table clamp made on paper. This tracing is taken to the table and put in relation with the table clamp. The localizer is then made to occupy its original position, and threads are carried from the notches on its cross-bar to the tracings of the foreign-body shadows. At the crossing of these threads is the position of the foreign body in relation to the localizer. The point of the fourth adjustable rod can be made to touch the cross-threads from any direction. If the Röntgenologist cannot determine the best direction for incision, he may consult the surgeon, and when this is known, the point of the rod is made to touch the crossing of the threads, and its collar and set-screw fixed.

At the operation for removal of the foreign body the localizer is sterilized and applied to the patient, preferably by the Röntgenologist, if he has had sufficient surgical training to render his assistance of value from the standpoint of surgical technic; or he may thoroughly instruct the surgeon in the manipulation of the apparatus. The following precautions are to be observed: First, the localizer must be handled carefully to prevent displacement of the rods; and second, the patient should be placed on the operating table in about the position he occupied on the Röntgenographic table, so that the three marked spots on the skin receive the three fixed points of the localizer. With the apparatus in position, the indicating rod is placed in its carrier or sleeve, and when its point touches the skin the long axis of the rod indicates the direction of incision, while the distance between the collar on the rod and the sleeve shows the depth at which the foreign body lies. During the course of the operation the localizer should be repeatedly applied, so that excessive manipulation of the tissues may be avoided.

The determination of the localization of pieces of metal, glass, or other substances in the eye or immediately adjacent structures by means of the Röntgen rays requires that the shadow of the foreign body, as shown on the radiograph, be studied in relation to the shadow of one or more opaque objects of known position. Dr. William M. Sweet has designed a localizing apparatus which consists of two ball-pointed indicating rods, one opposite the center of the cornea and the other situated at a known distances from the first to the temporal side. The patient is in the recumbent posture, with the photographic plate to the side of the head corresponding with the injured eye. Two negatives are made, one with the tube horizontal or nearly so with the plane of the two indicating rods, and the other at any distance below this plane. A special chart is employed, containing a section of the normal adult eyeball, and lines are drawn indicating the planes of shadow at the two exposures. Where these planes cross is the position of the foreign body in relation to the structures of the eyeball and orbit.

The accuracy of this method of localization has been fully demonstrated by its author and other x-ray workers, but the student found considerable difficulty in understanding the lines to be drawn upon the chart to represent the planes of shadow at the two exposures, so that Dr. Sweet has recently designed an entirely new apparatus, in which a single indicator is employed. As shown in the illustration (Fig. 907) the tube-holder, indicating-ball, and plate-holder are upon a movable stage, and the tube is in a fixed carrier, so that the angle of the rays with the eyeball and the distance of the tube from the plate are always the same. A telescope and reflecting mirror permit the observer to adjust the instrument until the image of a cross-wire in the tube is in direct contact with the lateral image of the summit of the cornea. After this adjustment is made, the indicating-ball is exactly 10 millimeters from the center of the cornea.

The patient fixes with the good eye upon a circular mirror placed 12 inches above the injured eye, so that there is no movement of the eye during exposure, and the visual line of the injured eye is parallel with the plate. The two exposures are made upon one plate, one with the tube in the zero position of the apparatus, so that the rays pass in a direction corresponding with the horizontal plane of the eyeball; and the second exposure with the tube at its farthest

point on the graduated rod to the right or left of the first position, depending upon which eye is to be examined. Two metal shutters are used to uncover any desired portion of the photographic plate.

Since the relative position of the tube in reference to the indicating-ball and the photographic plate remains fixed and known, the direction of the rays in passing through the eyeball follows a definite course, which is the same for the two separate exposures. Lines have, therefore, been drawn upon the localizing chart to indicate the direction of the rays at the two exposures, each line with the required amount of divergence to represent rays coming from a point

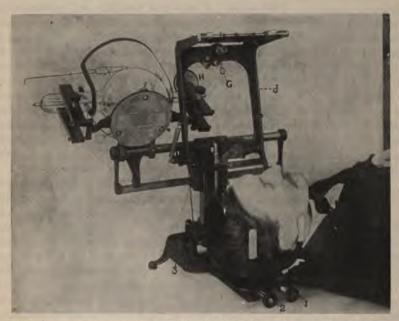


Fig. 907.—Sweet's apparatus for locating foreign bodies in the eyeball and orbit.\*

the distance of the tube from the photographic plate. After development the photographic plate is placed in a frame containing cross lines indicating the focal coördinates of the rays. The radiograph is moved until the shadow of the indicating-ball is in apposition with a spot representing the indicating-ball on the key-plate. A reading is then made of both the vertical and horizontal coördinate lines which pass through the shadow of the body on the radiograph, and this is transferred to the corresponding lines on the localization chart. Three readings are taken, and after having been transferred to the chart, the point of crossing of the several lines indicates the location of the foreign body in the eyeball or orbit.

The accuracy of the localization depends only upon the care with which the operator adjusts the indicating-ball opposite the center of the cornea and

<sup>\*</sup>Transactions of the American Ophthalmological Society, 1909.

at a definite and fixed distance from it. After the exposures are made and the plate developed, the determination of the situation of the foreign body is simply a question of reading from a key-plate and transferring these readings to a localization chart.

The x-Rays in the Treatment of Diseases.—It may be said that the beneficial results obtained through the use of x-rays is in direct proportion to the skill of the Röntgenologist. No two Crookes tubes are alike in their behavior, they vary widely from day to day, and even during one

operation.

Unfortunately there is no accurate method of computing dosage either in quality or quantity. The quality of rays may be fairly well estimated by determining the electric resistance the tube manifests. Tubes of high vacuum offer great resistance, and emit hard or highly penetrating rays, while tubes of lower vacuum offer less resistance to the passage of the electric current and emit softer rays. The quantity of a certain quality of rays may be roughly estimated by the amount of current passing through a tube of known vacuum in a definite period of time. The instrument commonly used in this country for this purpose is known as the milliamperemeter, the standard of measurement of electric units. In Europe the physiochemic properties of the rays are more in vogue as a means of measurement of dosage. In the United States most Röntgenologists give repeated short exposures, while abroad the tendency is to use infrequent but powerful applications of the rays.

In any case, ability gained by experience is essential for the proper selection and control of the Crookes tube in the treatment of a given condition.

The effects of x-rays which offer possibilities of therapeutic application are, according to Pusey, as follows ("The Röntgen rays in Therapeutics and Diagnosis," Pusey-Caldwell): (1) "Their effect in causing atrophy of the appendages of the skin; (2) their destructive action upon organisms in living tissues; (3) their stimulative action upon the metabolism of tissues; (4) their power of destroying certain pathologic tissues; (5) their anodyne effect." A qualitative generalization may be made, i. e., superficial diseases should be treated in most instances with tubes of low vacuum, while deeper-seated lesions should be exposed to the rays from tubes of higher vacuum. Quantitatively, for causing atrophy of the skin appendages, stimulating action upon metabolism, and for the relief of pain in other than malignant conditions, mild applications or short exposures should be given; on the other hand, for destructive action maximum exposures are demanded.

In diseases of the skin the surrounding healthy parts are to be protected from the action of the rays by means of sheet-lead, while the diseased portion is directly exposed. In treating lesions beneath the surface it may be necessary to expose an area beyond the evident limits of the disease, but all overlying healthy skin must be protected from the non-penetrating rays by a filter such

as aluminum or leather.

Because of the possible untoward effects of exposure to x-rays, diseased conditions amenable to other forms of treatment should not be treated by the rays except "as a last resort." It is strikingly true, however, that the most signal results of x-ray therapy are obtained in conditions that are frequently incurable by other means. Many of the chronic diseases of the skin that yield but slowly to medication will be found safely and promptly amenable to x-ray

treatment. Among these diseases are acne, eczema, lupus vulgaris, lupus erythematosis, and psoriasis.

The treatment is also beneficial in tinea tonsurans, favus, sycosis, alopecia

areata, hypertrichosis, and prurigo.

In the treatment of malignant growths the Röntgen rays find their greatest field of therapeutic usefulness. With improved technic, permitting of massive doses of the rays with safety to overlying and adjacent healthy tissue, the results are far more favorable than in the earlier x-ray days.

In superficial epithelioma, rodent ulcer, and Marjolin's ulcer, without glandular involvement, cure is the rule, recurrence is becoming less frequent

and is amenable to cure, and the cosmetic effect is good.

When deeper structures are invaded by carcinoma cure becomes less frequent and recurrence more frequent in direct proportion to the depth of the lesion and the degree of glandular involvement. Even in advanced cases, however, for instance when the entire contents of an orbit are involved, large portions of the nasal structure destroyed, or extensive areas of subcutaneous tissue the seat of foul and painful ulceration, and where operative interference is contraindicated, the x-rays relieve pain and decrease discharge. Some reach a stage of improvement where surgical procedure may be instituted with hope of success, and in a few actual cures result from x-ray treatment alone.

Epitheliomata involving mucous membranes, particularly of the lower lip, anus, or vagina, should not be treated by x-ray until after surgical methods have been exhausted. The rays are used to prevent recurrence after operation. The reason why the rays should be regarded as a last resource in these cases is that mucous membranes are very susceptible to the action of the rays and are as apt to be destroyed as are the cancers. Further, in the lower lip, glandular involvement is almost sure to exist. All forms of carcinoma with glandular involvement, if operable, should be subjected to radical surgical extirpation, and the rays should be used only as a prophylactic measure against recurrence.

It is difficult to determine the value of x-rays in this capacity, but theoretically they should be of use.

All cases of primary inoperable carcinoma, regardless of situation, extent of involvement, or cause for being inoperable, should be exposed to vigorous irradiation. Likewise, all recurrences after operative procedure is prohibited ought to be afforded the possible benefits of x-ray treatment.

In sarcoma the results are becoming more favorable also, but this form of treatment is by no means on a basis of success that it may interfere with or supersede surgical methods. It is a fact, however, that in some cases in which operation was not agreed to by the patient or parents, or in which the condition was deemed by the surgeon to be inoperable, surprising results have been obtained with the Röntgen rays alone or in connection with the use of Coley toxins. I know of a case of rapidly growing periosteal sarcoma of the humerus in a young girl, the onset of which was so rapid that the mass was considered to be a subperiosteal abscess, but which was proved by x-ray examination and later by incision to be sarcoma, that has remained well eighteen months after treatment by x-ray and Coley toxins at first, and later by x-ray alone. The arm is strong and useful, and the girl is robust. At the site of

origin there remains a spur of bone which is about 1 inch long, ½ inch in thickness, and has a density equal to that of the densest portion of the humerus. Isolated cases of inoperable retroperitoneal sarcoma, fibrosarcoma of the uterus, and other deep-seated tumors, clinically or after exploratory operation considered sarcoma, have been reported as greatly benefited, controlled, or cured.

Good results in x-ray treatment of inoperable sarcoma are obtained only with the best apparatus. In the deep-seated growths hard, penetrating rays in maximum quantity are demanded. The treatment must extend over a period of months, so that great care and skill is required. There is little reason to believe that x-rays cause metastatic involvement in other parts.

Tuberculous sinuses that are not deep seated are frequently quickly benefited, and old tuberculous glands in which ulceration has recurred after operation should always receive the x-ray treatment, as some remarkable results have been obtained.

Of late years exophthalmic goiter has been treated more or less successfully with Röntgen rays. It is distinctly of value in many cases that are not operable or amenable to other forms of treatment. The Mayos use the rays for a time before operating. Many of the distressing nervous symptoms are relieved, the pulse-rate is materially lowered, and changes favorable to future operation take place in the gland and its capsule. Dr. Manges, the Röntgenologist at Jefferson College Hospital, in an extreme case of exophthalmic goiter, has obtained a remarkably good result from x-ray treatment, so far as relief of the nervous symptoms, tachycardia, and improvement of the general health of the patient are concerned. There is not a marked diminution in the size of the goiter, but the exophthalmus is distinctly less. The patient has been following her occupation as a weaver without inconvenience for nearly a year.

Here again more data is to be desired before other methods of treating this disease, especially surgery, are to be replaced by Röntgenization. These rays are perhaps the most valuable therapeutic agent we have in the treatment of myelogenic or splenomedullary leukemia and lymphatic leukemia. Since Senn's report some years ago this plan of treatment has been widely used in connection with other remedies. A spleen of enormous size will sometimes go back to normal, high leukocyte counts disappear, red cells and hemoglobin increase, and the general health of the patient improves. Stengel and Pancoast have decidedly improved the technic of x-ray treatment in their systematic exposures of the bony skeleton, particularly the long bones, with comparatively little irradiation of the spleen until late in the course of treatment.

Very advanced cases are apt to improve greatly for a time, but even in the early cases recurrence usually appears sooner or later, and becomes less responsive to treatment. Life may be prolonged for many years, but permanent cure is rare.

Chronic suppurating sinuses sometimes heal under the influence of these rays, and varicose ulcers are benefited by moderate exposure. The pain in rheumatic affections and neuralgias is often greatly relieved.

### THE FINSEN LIGHT.

It is known that below the spectrum of white light are heat rays and above the spectrum of white light are short violet, actinic, or chemical rays. The short violet, with the indigo rays and blue rays, constitute the Finsen light. Ultraviolet rays cause an electrified body to discharge, excite fluorescence in certain substances, affect a photographic plate, and are bactericidal but have little power of penetrating tissues and, it is said, do not inflame tissues. Ultraviolet rays pass readily through rock salt or ice, which will not transmit heat-rays.

Finsen taught us to use these rays therapeutically. He first obtained the rays from sunlight, intercepting the heat-rays by ice or rock crystals. Later he obtained them from the arc light.

Blood in part prevents the passage of the Finsen light, hence in using the light we must make the area on which the rays are to act nearly bloodless. This is done by pressing firmly upon the part with a rock crystal through which water passes. The rays pass through the crystal and the water absorbs the heat-rays. The rays are especially serviceable in lupus.

### BECQUEREL'S RAYS.

Becquerel discovered in 1896 that uranium and some of its compounds give off a radiation similar to but much weaker than the x-rays. Among these radiant substances are pitchblende, radium, and uranium. These rays are luminous, actinic, and skiagraphic (McFarland), and may produce, by prolonged action, dermatitis similar to an x-ray dermatitis.

#### RADIUM RAYS.

Monsieur and Madame Currie, after prolonged research, found that thorium and certain ores of thorium and uranium (pitchblende) are radio-active, pitchblende being more strongly so than uranium itself. The conclusion was that pitchblende contained a strongly radio-active element and that it was not uranium. In 1903 they discovered the sources of radio-activity to be two hitherto unknown elements, radium and polonium (see Dawson Turner in "Brit. Med. Jour.," Dec. 12, 1903).

Turner tells us (Ibid.) that radium gives off a radio-active emanation and three kinds of rays (alpha-rays, beta-rays, and gamma-rays). It also emits heat, and is itself at a higher temperature than the medium in which it rests. The emanation from radium is a luminous gas, which can be condensed by great cold, and which imparts radio-activity to certain bodies. It is to this gas that most of the curative effects of radium can be attributed.

Alpha-rays consist of a stream of positively charged gaseous particles. Turner points out that these particles are each about twice the size of a hydrogen atom, travel at a velocity of 20,000 miles a second, and have little power of penetration. In fact, the pentrating power of the alpha-rays is so slight that they do not pass through the glass of a tube (Robert Abbe in "Med. Record," Oct. 12, 1907). The beta-rays consist of particles each being  $\frac{1}{1000}$  the size of a hydrogen atom and being strongly actinic. These rays are said by Turner to resemble cathode rays and to be far more penetrating than alpha-rays. Gamma-rays resemble x-rays and have great penetrating power (Dawson Turner,

in "Brit. Med. Jour.," Dec. 12, 1903). It is probable that radium also generates or helps to generate a gas called helium, which has no action on tissues.

The actions of radium are extraordinary. A man entirely blind cannot perceive light when radium is brought near him, but one not quite but almost blind can, and one quite blind to form but with retention of some light perception can actually see the shapes of objects near a screen rendered luminous by radium (Turner). Turner tells us that a man retaining vision, who covers his eyes, can detect radium held in a box behind his head. If dry seeds before planting are exposed to radium rays sprouting will be retarded in proportion to the time of exposure. When meal worms are exposed to the rays "they go on living as meal worms, 'veritable Methuselahs,' as it has been said, while their sisters and brothers, unradiumized, progress for generations, completing several cycles of beetles, eggs, meal worms, etc." (Abbe, Ibid.). Radium rays are germicidal, but act very slowly and feebly. Skiagraphs can be taken with the rays. Water and other materials may be rendered radio-active by exposure to radium rays. Probably certain natural waters have subtle powers due to radio-activity. On the tissues radium may act to produce a retrogressive effect; may increase self-digestion; may cause irritation and inflammation, and so block blood-vessels. Severe reaction may result in ulceration. Sometimes a spreading eruption, like that of scarlet fever, follows overaction. Abbe says that when an ulcerated surface is treated or when a tube of radium is inserted in a wound for twenty-four hours, a "specific toxemia" frequently arises. "The symptoms will be headache, chill, general aching, coated tongue, fever up to from 103° to 106° F., and an occasional rash-like scarlatina" (Abbe, in "Med. Record," Oct. 12, 1907). Some hold that radium acts similarly to the x-rays and that the x-rays can do anything radium can do. Most observers believe that the radium rays have a specific action and can accomplish things impossible to the x-rays.

Radium therapy is assuming a high degree of importance. How great its future is to be we can only guess. Sir Frederick Treves bids us be cautious in our estimates, although he thinks there may be a great future for radium therapy in surgery ("Brit. Med. Jour.," Jan. 30, 1909). It has cured many surface carcinomata and sarcomata, keloids, angeiomata, moles, pigmented moles, and warts. It is particularly valuable in lesions about the face when it is desirable to avoid scars; in lesions of the nostril, mouth, and other cavities. It has been used most advantageously for epithelioma of the eyelid (see the striking cases reported by Abbe, in "Med. Record," Oct. 12, 1907). When treating a surface lesion the rays are obtained from radium bromid, which material is kept in a hermetically sealed glass tube. In a deepseated tumor an incision may be made and a tube of radium bromid be inserted in the wound and allowed to remain for some hours or a number of hours. Attempts are being made to treat internal conditions by the inhalation of radium emanations or by the administration of materials which have been rendered radio-active and contain, so to speak, radium emanations in solution. Radioactive water has been tried for cancer of the stomach. It is extraordinary how even very brief applications may be followed by notable changes. In one of Abbe's cases an epithelioma of the forehead disappeared after one exposure of an hour's duration. Another on the side of the nose disappeared in four weeks

after one exposure of an hour's duration. A cancer involving one-third of the upper eyelid entirely disappeared in two weeks after three five-minute exposures. After an exposure no changes are apparent for several days or a week. The skin at the site of application then begins to burn and itch and becomes reddened. The irritation endures for about two weeks.

Confusion has arisen because of the varying strengths and amounts used by different operators. Bromid of radium is the salt usually employed. Abbe takes as a standard 10 mgr. of bromid of radium and tests other specimens by this (see his method of testing in previously quoted article). He calls the 10 mgr. of strong German bromid of radium "the working unit." In malignant disease the best results have followed one hour's exhibition of the "working unit" to small growths and three or four hours to large growths, "with an interval of one month for study of the effect" (Abbe, Ibid.). Ischemia favors powerful action of radium rays.

#### XL. INJURIES BY ELECTRICITY.

Effects Produced by Lightning.—Every year in the United States about 224 persons are killed by lightning (McAdie). An individual may be struck directly or he may be shocked by the lightning having struck a nearby object. A person can be struck while in a room, but there is more danger when exposed, especially in the open country. To be under a single tree or under a tree at the margin of a forest during a thunder-storm is dangerous, but to be in a wood or under a hedge is reasonably safe. The oak is struck more often and the beech less often than other trees (Professor McAdie, quoted in "Draper's Legal Medicine"). It is not safe during a thunderstorm to stand by a chimney or fireplace, in an open doorway, or close to cattle (Professor McAdie, Ibid.). One should not use a telephone or ring a bell during a storm. It is unwise to run, as the current of air thus created is a danger. Telegraph posts should be avoided. A pool of water is a dangerous neighbor. Horses and other animals should be given a wide berth. The victim of lightning may be killed instantly. The body may show no mark, but there are usually burns. Burns may be superficial or a large area (as a limb) may be carbonized. Death is the fate of over one-third of those struck. Tidy states that out of 54 cases, 21 died and 33 recovered. Recovery may follow even when there has been severe burning. Post-mortem examination may fail to reveal a lesion, but in many cases severe burns are discovered; in some there are laceration of tissue, crushing of bones, and fearful injury. Burns are especially apt to occur at the points where the current entered and emerged. The clothes are usually singed or torn, shoes are especially apt to be torn apart or destroyed. Yet a man may be burned or killed and the clothing be undamaged, or the underclothing may be destroyed and the outer garments escape uninjured. A person's clothing may be destroyed, he may be left naked, and yet he may not be injured. Clothing may be cast far off, and in some cases is said to have utterly disappeared. The typical lightning-marks are arborescent tracings, representing the course of bood-vessels, produced by disorganization and

effusion of blood as the fluid travels through it. Occasionally metal objects, such as buttons, knives, money, keys, etc., are fused, and spread as a metallic film over a considerable portion of the surface of the body. Bichat stated that in death from lightning rigor mortis does not occur. This statement is now known to be an error (see the 3 cases reported by M. Tourdes). As a rule, there are early but perhaps brief rigor mortis, retained fluidity of blood, and distention of the brain with venous blood. Putrefaction is early and rapid. A man killed by lightning may remain in the exact attitude in which he was struck dead. He may not be disfigured, his clothing may be intact, and yet, almost at a touch, he may crumble to ashes because the body was practically incinerated (see the apparently authentic cases quoted by Flammarion in "Thunder and Lightning"). In most cases killed the body shows burns. The cause of death by lightning was supposed by Hunter to be destruction of muscular contractility, and by Richardson the resolution of the blood into gases. It is asserted that some deaths are due to actual disorganization of vital structure and that others are due to shock or inhibition. Spitzka believes that death from electric shock is due to asphyxia, to paralysis of the heart with fibrillary contractions of that organ, or to a combination of these conditions. An individual struck by lightning may recover even when he is apparently dead. Sestier collected reports of 77 persons struck by lightning; 7 of them were apparently dead for a number of hours, but finally reacted.\* Brouardel says in such cases the death-like state may be ascribed to inhibition. caused by a maximum degree of stimulus.† When death from lightning is not immediate, the condition may be as above outlined, the individual being apparently dead, without obvious respiration or pulse. He may be insensible, with slow and labored respiration, a weak and irregular pulse, and dilated pupils, and may remain in this condition for a few minutes or for several hours. The above condition is not to be distinguished from severe concussion of the brain. Every individual suffering from the effects of lightning should have his entire body carefully examined to see if physical injuries exist (fractures, wounds, burns, ecchymoses, arborescent tracings). The consequences of lightning-stroke are many and various. There may be rapid and complete recovery, gradual recovery, traumatic neurasthenia, sloughing burns, partial paralysis, which is usually recovered from (Nothnagel), but which may be permanent; hysteria, blindness, change of character, and actual insanity.

Treatment.—Do not pronounce a person dead until a thorough attempt at resuscitation has been made. Raise the head a little, draw the tongue forward, make artificial respiration, occasionally tickle the epiglottis, apply external heat, massage over the heart, and, if the means are at hand and the man is apparently dead or all but dead, throw salt solution and adrenalin into a large artery and toward the heart, as advised by Crile and Dolley (page 467). Do not give alcoholic stimulants. If the respiration is feeble, make tongue traction and employ artificial respiration. Apply the stream of a warm douche to the head, rub the limbs with mustard, put a mustard plaster over the heart and another to the back of the neck, wrap the individual in hot blankets, give enemata of hot saline fluid, and strychnin hypodermatically. In some cases

<sup>\*</sup>Sestier, "De la Foudre," Paris, 1866. Quoted by Brouardel în his lectures upon "Death and Sudden Death."
†Benham's translation of Brouardel's lectures upon "Death and Sudden Death."

venesection has seemed to be of benefit. Lumbur puncture may be tried. When the individual reacts, treat any existing condition symptomatically,

and treat particular physical injuries according to their character.

Effects of Artificial Currents.—Individuals may receive dangerous or fatal shocks by contact with wires carrying a powerful electric current, by contact with a dynamo, or with some metal object which has become accidentally charged by a powerful current. The shock may be from contact with both poles of a circuit (while standing on the ground and touching one pole of a grounded" circuit); when actual contact has not occurred, but a person has been very close to a high-tension current and the current has jumped an inch or several inches through the air; when a person insolated from the ground grasps the conductor with both hands (Spitzka, Journal Med. Soc. of New Jersey, 1909). Workmen for electric companies, pedestrians in the streets of a city which is lighted by electricity or in which trolley cars are employed, roofers, and firemen are liable to be injured by electricity. During many fires in cities live electric wires fall and charge the rails of a street-car track, the iron of a hook-and-ladder truck, water-tower, or a fire-escape. Firemen who come in contact with such charged materials are shocked. I have seen dozens of men thus shocked, but have as yet seen no fatal case. There are enormous differences in individual resistance and susceptibility. Spitzka points out that in one case death followed a shock of 65 volts, and others have survived shocks of many thousand volts. The amount of current the individual gets from the circuit is influenced by the tension of the current; the ground he stands on (metal floors and wet floors are most dangerous); the area of contact (limited area of contact means serious burning and less general shock, broad area means little or no burning and severe shock); the nature of the tissue (the thick palm offers less resistance than the lip and the more callus the palm of the hand the greater the resistance), and the duration of the contact. An alternating current is decidedly more dangerous than a continuous current of equal strength. The constant current causes a shock only as the circuit is opened and closed. While the current is passing continuously there is no shock, although dreadful burns may be caused at this time. The alternating current causes rapidly repeated violent shocks. The arc light is either an alternating or a direct current. "Low-tension currents with 30 to 150 alternations are more dangerous to the heart than if of more than 500 frequency. Greater frequencies, as in Tesla's currents, are practically harmless" (Spitzka, Ibid.). An artificial current acts like lightning. It may produce instant death, it may produce unconsciousness, delirium, stertorous respiration, Cheyne-Stokes' breathing, or clonic spasms. Its effects can be often recovered from. Not unusually the victim is apparently dead, but subsequently recovers. D'Arsonval reports the case of a man who was apparently killed by the passage of 4500 volts. No attempt at resuscitation was made for one-half hour, and yet he recovered when artificial respiration was employed. Donnellan reports a case of recovery after the passage of 1000 volts. Slight shocks may cause temporary numbness and even motor paralysis. An electric shock frequently causes burns or ecchymoses and, occasionally, wounds. Wounds caused by electricity bleed profusely and are apt to slough. Spitzka, Ibid., sets forth the effects of electric shock as follows:

"I. Local Signs:

(a) Burns of the skin and hair.

(b) Puncture and rupture of tissues,

(c) Superficial necroses.

(d) Metallic impregnation of the surface tissues.

(e) Hemorrhages.

(f) Edema, erythemas, 'lightning' figures.

"II. General Effects:

(a) Loss or consciousness and of nerve-functions generally.

(b) Paralyses or spasms of muscles.

(c) Disturbances of respiration and cardiac action; high temperature "Later. Affections of the bowel activity: meteorism, constipation, albuminuria, icterus, incontinence or retention of urine, bloody urine, arterial rigor or spasms of arterioles, acute edema of various parts (joints); eyesymptoms of various kinds: blinding, conjunctivitis, keratitis, iritis, cataract, dislocation of lens, etc.; ear-symptoms: rupture of tympanic membranes, deafness, bleeding, epistaxis; thermal symptoms: usually a rise of temperature

to 38° to 39° C., amnesia, neuritis, etc."

If death occurs it is due to asphyxia, to cardiac paralysis with fibrillary contractions of the heart, or to both conditions (Spitzka, Ibid.). An electric burn looks like a blackened crust; it is surrounded by pale skin, and for twenty-four hours remains dry, when inflammatory oozing begins and the skin around it reddens. These burns are seldom as painful as ordinary burns, but sometimes cause severe pain, and recovery requires a long time. When inflammation begins and suppuration occurs, tissue is extensively destroyed; tendons, bones, and joints may suffer; some portions become deeply excavated, and other portions show dry adherent masses of dead and dying tissue, and a burn which was at first small may be followed by a large area of moist gangrene;\* lack of tissue-resistance, due to trophic disturbance, is largely responsible for the progress of the sloughing. Even an apparently trivial burn may be followed by extensive sloughing.

Treatment.—If a person is in contact with a live wire, the first thing to do is, if possible, to shut off the current. If it is not possible to shut off the current, catch a portion of the clothing of the victim and pull him away from the wire, but do not touch his body with the bare hand. If a pair of rubber gloves can be obtained, the subject can be moved with impunity and the wires can be safely cut. If it is not possible to drag a person away from electric wires, an individual can wrap his hands in dry woolen material and safely lift the portion of the body in contact with earth or wire, and thus break the circuit and permit of removal of the body.† A dry cloth can be pushed between the body and the ground, and the body can then be removed from the wires. It may be possible to push the wires away by means of a dry piece of wood, or to cut them with shears which have wooden handles and which are perfectly dry, or to push or draw the body away from the wire by the employment of sticks of dry wood. Spitzka warns us to be careful in using shears "as the momentary are formed between the separated ends may blind the rescuers."

<sup>\*</sup>See the article by N. W. Sharpe on "Peculiarities and Treatment of Electrical Injuries," in Phila. Med. Jour., Jan. 29, 1898. †See the directions in Med. Record, Dec. 28, 1895, from Med. Press.

Treat the general condition in the manner set forth in the article on Lightning-stroke (page 1462). Raise the head a little, apply external heat, draw the tongue forward, and at once make artificial respiration. Occasionally tickle the epiglottis with the finger. Massage over the heart region. If facilities are at hand and the victim is apparently dead, inject at once adrenalin and salt solution into a large artery (page 467). While any heart action remains there is a chance of resuscitation. When heart action and respiration are present the prognosis is good. Very severe burns may be caused. The author has dressed a number of electric burns with hot fomentations of salt solution during the first few days. This facilitates the separation of the sloughs and seems to aid the weakened tissues in resisting microbic invasion; after sloughs separate, the part is dressed with dry sterile gauze. Antiseptic dressings can be used from the beginning, but they often fail entirely to arrest the sloughing. Iodoform produces much irritation and should not be employed. Ointments are very unsatisfactory. When the dressings are changed, the part should not be washed with corrosive sublimate, as this agent produces irritation; peroxid of hydrogen should be employed, followed by warm normal salt solution. Sharpe removes sloughs by applying the following mixture: 2 parts of scale pepsin, 1 part of hydrochloric acid, U. S. P., 120 parts of distilled water. This mixture is washed off after two hours with peroxid of hydrogen. The same surgeon treats necrosis of bone by injecting every few hours a 3 per cent. solution of hydrochloric acid, using every second day the pepsin solution, and when necrotic areas come away, packing with gauze. When repair begins, the raw surface should be covered with silver-foil. Skin-grafting by Reverdin's method or Thiersch's method is rarely successful. In some regions it is possible to slide a large flap in place to cover a granulating area which will not heal. In a very severe case amputation or resection may be necessary.

In New York and New Jersey and several other states electricity is employed to execute criminals convicted of capital offenses. The infliction of death by electricity is popularly spoken of as electrocution. It is beyond doubt, in the words of my colleague, Dr. Spitzka, "the most humane method of executing criminals." The first electrocution in New York was in Auburn Prison in 1890, and since then over 100 criminals have been executed by electricity in New York state alone. Dr. Spitzka has witnessed 36 electrocutions and made autopsies on 27 of the victims ("Journal Med. Soc. of New Jersey," 1909). The apparatus used is "an alternating dynamo capable of generating 2000 volts, a 'death-chair' with adjustable head-rest, binding straps, and adjustable electrodes. (At Trenton a 2400-volt current is taken from the public service wire and lowered to the desired tension by a rheostat.)" bound to control the current is in the death-chamber and the dynamo is in another apartment, communication being had by electric signals. The prisoner (usually without fetters) walks in when everything is ready and sits down in the chair, and his arms, legs, head, and chest are strapped to the chair. An electrode moist with salt solution is fastened to the head and another to the calf of the leg. The head need not be shaved.

"The application of the current is usually as follows: The contact is made with a high potential—1800 volts—for five to seven seconds, reduced to 200 to 250 volts until a half minute has elapsed; raised to high voltage for

three to five seconds; again reduced to lo elapsed, when it is again raised to the high v contact is broken. The ammeter usually s have passed through the criminal's body.

"A second or even a third brief contac precautionary measure, but more to comple

body.

"The time consumed by the strapping-in seconds and the first contact is made a few to seventy seconds elapse from the momen he is shocked to death" (Spitzka, Ibid.).

After electrocution the temperature of 129.5° F. Dr. Spitzka finds that after ren in the vertebral canal is often over 120° F. rhages, arterial anemia, and venous congest sections of the pons, oblongata, and spinal core emphysema, which were perhaps caused by

In electrocution there is no pain, con death is certain, and resuscitation is impocriminals being killed by the necropsy and nonsense.

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